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I. THE MORTALITY OF LIVERPOOL, AND ITS NATIONAL DANGER.

In the course of the last year this country has been visited by a cattle murrain, the history of which may be summed up in a few words. It came, we know not whence, although we are aware that such a plague exists in certain continental countries; it raged, and we know not what kind of disease it is, by what laws it is governed, or why it appeared in certain places, disappeared, and sometimes appeared again. We know that in some districts it was the most virulent where there was a want of cleanliness in the stalls, whilst many well-regulated farms escaped its ravages, and that is about all that science has reaped from the visitation. Every precaution was taken by the State to prevent its spread, and chiefly should those efforts have been successful in excluding it from Ireland; yet it appeared at length in that country also. The Clergy prayed for its removal, the nation (at least by deputy, through the State) humiliated itself for its sins, and probably in the due course of conventionality, the people will in a similar manner set apart a day for thanksgiving, when it has pleased Providence to allow this visitation entirely to pass away.

Whether the same invasion (if it be an invasion), the same destruction of live-stock, the same perplexity and the same religious processes will be repeated in another decade or so, remains to be seen, and will depend greatly upon the amount of improvement which takes place in the method of conducting farms, and the degree of application brought to bear upon the scientific question by veterinary surgeons, chemists, and physiologists. In the case of the cattle-murrain, the panic and helplessness of the nation has been to some extent justifiable, for our Statesmen knew nothing of the approaching danger, nothing of its nature when it came, and their professional advisers were in the same boat with themselves. But in the case of the human plague raging in the country, and recently aggravated by importations from abroad, there is no such excuse; and on this subject we now desire, while there is still time for warning, to address a word to the nation, and, not to the Government, but to the Representatives of the people.

In the House of Lords, on the 15th of May last, the Earl of Carnarvon "moved for Copies of Correspondence," in other words, sought information concerning the outbreak of cholera in Liverpool. He stated the fact, well known to their Lordships, that "a large number of German emigrants had landed at Hull, and had travelled by railway to Liverpool, and it was at Liverpool, without an exception, that all these cases had arisen. The most formidable outbreak had occurred on board a vessel that had sailed from Liverpool to New York. It was at Liverpool again, and among this body of emigrants that diarrhœa and typhus had been prevalent, and the House was aware that diarrhœa was the first stage, and, at all events, the harbinger of cholera. The habits of these emigrants were the reverse of clean, and they were congregated together in the most unhealthy quarters of the town. A case had been stated where 150 of these emigrants lived in one house in Liverpool, and forty in a single room. If these persons really came from cholera-infected countries, were these not all the conditions that would justify them in expecting cholera to break out?"*

Earl Granville, who, be it remembered, was at least the nominal head of the Committee which managed the cattle-plague, stated what steps had been taken to prevent the importation of cholera; observing that it would be impossible to enforce a system of quarantine in Great Britain, and remarking further, that a letter which had been issued by the Privy Council insisted upon sanitary regulations, "which really might be summed up in the terms fresh air and fresh water, and some of the outports really stood in urgent need of sanitary measures."†

In the House of Commons, the Right Honourable H. A. Bruce, the virtual head of the Cattle-plague Commissioners, gave the same information in reply to a similar question; and in the course of his remarks he observed that, "we were accustomed to think of cholera as marked by clear and unmistakable symptoms, and the stage of collapse was no doubt one about which there could be no mistake, but the earlier stages of the malady were not so easily discoverable. A person might have the disease lurking in his system for many days without suspecting it. He suffered but little pain, and the symptoms were such as persons often experienced without any interruption of their ordinary vocations. It would, therefore, be impossible, unless communication were absolutely forbidden between England and the infected countries, to expect that quarantine laws would prevent the introduction of the disease."

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* 'Times,' May 15, 1866.

† Ibid.

He stated further, that "he thought it would be better to leave the matter in the hands of the local authorities, as there was a general objection throughout the country to Government interference;" and also, that "the best security against the disease was for the local authorities to supply their towns with pure water, and to thoroughly clean and drain their houses."*

'The Times' newspaper reviewed the subject in a leader on the day when these remarks were reported in its columns, and thus disposed of the whole question:

"Better stop the imports" (of emigrants) "at Hull."

Before we state briefly to our readers what is known to science of the march of cholera, we will just extract from the preceding observations the opinions of the Legislature and of the Press on the subject:

1. They believe that it is impossible to enforce quarantine; and if it were, the disease is so capricious in making its appearence in individuals that it would be useless to do so.—In other words, *it is impossible to prevent the importation of cases of continental cholera.*

2. The local authorities object to Government interference; and it is for them, by the employment of sanitary measures, to render it innocuous when it touches our shores.

3. Nevertheless 'The Times,' which may be said on such a question to reflect public opinion, recommends the stoppage of the passenger traffic, and by that means the exclusion of the cholera.

From this summary our readers will be able to form their own opinion as to the amount and value of the advice and assistance likely to be afforded by the State in case of an outbreak of epidemic disease more virulent than that which already exists in the country!

Now it happens, fortunately for those who like to avail themselves of that channel for information, that Dr. Francis E. Anstie, the senior assistant-physician to the Westminster Hospital, has just published a most valuable little book on Epidemics, intended "for the use of the public,"† in which the whole question is concisely and ably reviewed, and we have marked the following observations for extract, as they will convey to our readers all that will be requisite for our consideration at the present time.

First, as regards *Typhus*:—

"Typhus first makes its 'nest,' to use a cant word which is dismally prevalent just now, in the courts and alleys inhabited by the very poor. Unlike relapsing fever, it is a very mortal disease; and, moreover, the contagion is much stronger than that of relapsing fever."‡

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* 'Times,' May 15, 1866.

† 'Notes on Epidemics.' By F. E. Anstie, M.D., F.R.C.P. Jackson, Walford, & Hodder. 1866.

‡ Ibid., p. 44.

Again :—"If famine be the great predisposing cause of typhus, over-crowding is something more ; for there is much evidence to show that it can actually excite the disease in destitute persons. In regard to this, the various synonyms under which typhus has been described at different times are highly suggestive : the old terms—'jail distemper,' 'camp fever,' 'hospital fever,' and the like, point to instances in some of which, no doubt, the disease was only fostered by crowding and deficient ventilation, but in great numbers of which typhus was probably actually bred from the circumstances of the time and place."*

Secondly, concerning *Cholera* :—

"No doubt the disease is still an *opprobrium medicinæ,*" (which we may venture to translate—Medical men know nothing of the nature of cholera ; and in a popular work such as Dr. Anstie's, they elect to acknowledge their ignorance in Latin!) "Yet something seems to have been learned, not merely guessed, about this mysterious pestilence in recent years."†

The following is amongst the information thus acquired :—

"'Neither climate, nor season, nor earth, nor ocean seem to have arrested its course, or to have altered its features. It was equally destructive at St. Petersburgh and Moscow as it was in India; as fierce and irresistible amongst the snows of Russia as in the sunburnt regions of India ; as destructive in the vapoury districts of Burmah as in the parched provinces of Hindostan.' (Goodeve). . . . . 'The most that can be said is, that the places in which the air is most vitiated from drains, decaying animal matter, and vegetable refuse, or *overcrowding and concentration of human emanations,* are those in which cholera has generally been most fatal and most widely spread.' (Goodeve.)" ‡

"It is indisputable that cholera originates in places without its being possible to trace any previous communication with infected persons." . . . . "Either the outbreaks which occur in this remarkable way may be instances of the generation of cholera *de novo* from insanitary conditions, or we may suppose the poison to have been carried by currents of wind."§

The author shows that there is good reason for believing it to have arisen in this country from both causes ; but, says Dr. Anstie—

"*There can be no doubt that, in the majority of cases, the march of the disease follows closely the lines of most frequent human communication: thus it always appears first, in any country, at the sea-port towns, and these places form the first centres of infection.*"‖

He recommends not only that vestries should be empowered, but compelled, "*for they will never do it properly of their own accord,*" to see that a proper and copious water-supply is laid on to every house, and that typhus patients should be removed to fever-houses specially adapted for such cases.

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* Notes on Epidemics,' pp. 45–46.

† Ibid., p. 90.

‡ Ibid., pp. 94 and 95.

§ Ibid., p. 106.

‖ Ibid., p. 105.

Legislation and science, then, are unanimous in believing—

1. That it is impossible to prevent the inroads of cholera into this country from abroad.
2. That it is in sea-port towns where it first makes its appearance.
3. That cleanliness, and an ample supply of fresh air and clean water, are the conditions which render it innocuous when it touches our shores; and
4. That it is the duty of the Guardians of Health in the large towns to see that these conditions are observed, without the necessity for State interference.

Having laid down these propositions, which are unquestionable as far as they go, it now becomes our painful duty to point out, as we did on a previous occasion,* that the very conditions which are so favourable for the admission from abroad and forcing of epidemics at home, are to be met with in our large sea-ports, and, in fact, that some of those towns are in a state of chronic pestilence. And although the illustration which we mean to lay before our readers may by some be considered an exaggerated one (and we sincerely hope that it is so), we fear that it too faithfully represents the state of things in the Metropolis and in the large provincial towns.

We must admit, however, that the case of Liverpool is somewhat exceptional, for that important sea-port, whose traders are denominated "merchant princes," has merited the reputation of being the most sickly, and, harsh though the criticism may appear, the most squalid and sin-stricken of all our important boroughs. Of course these remarks do not refer to those parts of the town where the wealth of the inhabitants is earned. Those, it is true, are surrounded by a feeble cordon separating them from typhus and other diseases (resulting from over-crowding, drunkenness, and every other kind of vice) which may be snapped at any moment, permitting the passage of the plague; but those parts are at present tolerably exempt from disease. Nor do we refer to the suburbs where the "merchant princes" enjoy their repose after the toils of the day are over. Every one of course knows that the portions of Liverpool which are inhabited by the wealthier classes rise above the level of the lower parts of the borough, where the thousands of poor Irish and the hundreds of emigrants lie huddled together like sheep in a fold; and that the suburban houses are built upon sandstone-rock, and swept by the breezes of the Irish Sea. Of these again it may be said, that of the shafts which are almost hourly aimed by Death into the nursery of fever below, a few fly too high, and reach the seats of affluence above.

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* "On the Predisposing Causes of Pestilence."—'Quarterly Journal of Science,' No. 7, July, 1865.

Since the subject was last discussed in these pages, we have received at regular intervals the "Reports of the Health of Liverpool" drawn up by a gentleman who, to judge from the care and patience which he bestows upon that task, must be eminently adapted for his duties. Dr. Trench, the Medical Officer of the borough, seems to have made up his mind that we shall not lose sight of the important subject of which he treats, and if his Report, just issued, receives a more conspicuous notice at our hands than such parochial or corporate returns usually obtain, it is, as we have already stated, because the information which he so diligently supplies is of interest, not to his own town alone, but to the nation at large. We will let him speak for himself as much as possible, and his figures will be found stubborn and terrible facts.*

"The returns made by the local registrars record 19,374 births and 17,282 deaths in the Borough of Liverpool during the year 1865."

The births and deaths are pretty equally divided between the sexes. "The total death-rate of the borough was 36·4 per 1,000." The deaths were 446 in excess of those registered in the previous year, and 1,744 above the corrected averages of the last ten years.

In his statement which particularizes the causes of death (one of the many interesting tables accompanying his Report), we find that of these 17,282 deaths, 7,766, or nearly one-half, were children under five years of age; and we are told that "the truest test of the sickliness of a place is the average death-rate of children." Again, although the average rate of mortality for the whole borough is 36·4, that of the parish of Liverpool alone, in which 11,251 out of the 17,282 deaths occurred, was 41·5; whilst that of the "out-townships," which we have referred to as being the more healthy portions of the town, ranges from 19·9 to 38·9, making an average of 29·6. "In the year 1860," the Report says, "a year of great prosperity, the deaths only reached 11,236, making the death-rate of the borough as low as 26·0 in the 1,000, the lowest hitherto recorded."

Six years since, therefore, the death-rate was 26·0 in the 1,000 for the whole town. Last year it was 36·4 for the same; 41·5 for the borough, and 29·6 for the out-townships. This will show the reader what Liverpool is, and what it might be made.

Now let us look at the causes of death, and whichever way we turn we encounter the word "zymotic." The diseases embraced by this term are the contagious and epidemic disorders—Typhus, Diarrhœa, Small-pox, &c.; and we are startled by the announcement that of the 17,282 deaths registered in 1865, 5,526 (or nearly one-third) are known to have resulted from zymotic diseases; and of these 2,338 were "typhus and infantile fever;" and 1,016 from diarrhœa—the diseases which press closely in the wake of drunkenness, debauchery (and that cause of both, overcrowding), as vultures follow the rear of a great demoralized army.

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* 'Report of the Health of Liverpool during the year 1865.' By W. S. Trench, M.D., Medical Officer of Health for the Borough. Liverpool: Hewson and Procter.

Dr. Trench has been so diligent as to make up corrected averages of the last ten years, that is, he has corrected those averages to the population of 1865, "so that the figures at once show the comparative deaths to population," and he has compared the deaths in 1865 with the average mortality of the past ten years.

Here is the result, fearful in the present, ominous for the future, not of Liverpool alone but unless some sharp remedy be applied of the whole country.

The total deaths in 1865.	17,282
Corrected average of the last ten years	15,538
Total deaths from zymotic diseases in 1865	5,526
From the same diseases in 1864	4,870
Average deaths from the same during the last ten years .	4,062

In other words, 656 persons died in Liverpool of contagious and epidemic diseases last year above the number who died of the same disorders in 1864; and 1,414 more than the average of the last ten years. Is there not in our land a gradually increasing, not a mere passing plague, more immediately dangerous to the locality in which it is being forced, but at the same time threatening to the whole community? If any one doubts this, let him study the growth of the pestilence in Liverpool, and he will find that it has been gradually spreading its ravages and widening the sphere of its cankerous influences. In some portions of the town, however, its effect has become so intensified that the medical officer feels himself warranted in regarding and specifying them as "the fever districts of the borough;" and if our readers will turn to the outline which we have sketched from the mortality map of the town that accompanies his report, they will perceive how large a proportion of the whole area of the Parliamentary borough is embraced by these infected localities. The three shaded patches are the "Fever districts." Lying midway between them is that portion of the town in which the trade of the port is conducted, and where its finest shop-streets are situated. Interspersed amongst these plague-patches are the noblest buildings in the borough; the Exchange and Town Hall, St. George's Hall, the Railway Stations, and nearly all the other buildings of note, such as the market halls, &c. The uncoloured portions beyond are on a higher level, Everton being probably the highest, but almost up to the very brow of the hill, the fiend "Fever" has made his home.

In the original map Dr. Trench has shown with red spots the number of deaths from typhus which occurred in the respective streets, and the mortality in some of them is positively frightful. If on some ball or festival night the roofs could be lifted from the houses in the fever-stricken districts, and the gay revellers hoisted, "*au diable boiteux*," to the top of the Town Hall, and provided with opera-glasses for the inspection of the interiors around them, we suspect they would go home sadder and wiser men and women, and would seriously consider the best method of bringing about in their city the much-talked of, but little practised, "Sanitary reform!"

We should have been glad to find in Dr. Trench's report a brief account of the number of cases of fever which have ended fatally as compared with those which have been successfully treated, and a comparison with former years. No doubt it would be difficult to draw up such a table, which would convey some idea of the efficiency with which the medical men had performed their duties and the increasing or diminishing curability of those diseases. To their causes we have already referred, cursorily here, and at length in our former article. *Overcrowding* with its concomitants, *drunkenness, immorality,* and *poverty,* these form the text from which sermons are preached daily in Liverpool, but preached in vain.

But there is one feature in this sad history which more especially merits the attention of our legislators and philanthropists. We will allow the able author whose report lies before us to describe it in his own terms:—

> "It is this mysterious selection of its most numerous victims from among those who are the parents and the bread-winners of families that constitutes the dreaded attribute of typhus; for their death not only brings sorrow and grief to the survivors, but spreads want and pauperism over a wide radius of the social circle. This peculiarity is aggravated in its effects by another singular feature of typhus fever. It is essentially a disease of the poor, and is as a rule confined to them, or to those of the better ranks, who, as clergymen, district visitors, physicians, and nurses, work in the dwellings of poverty, or to those who, as victuallers, undertakers, pawnbrokers, and small shopkeepers, are brought by business into direct communication with the affected. Of the whole 2,338 deaths, no less than 2,177 were of persons from the class which live by weekly wages. Of the remaining 161, eighty-nine were tradesmen, and sixty-three either the widows or members of the families of tradesmen; nine belonged to the class of the gentry or professions. Among the tradesmen were twenty-six licensed victuallers, besides twelve members of their families. Of the other tradesmen, twenty (*viz.* three milk-dealers, two butchers, eleven flour and provision dealers and four grocers) dealt in comestibles, and were likely to have come in frequent contact with fever patients or with persons directly from the sick-room; twelve (*viz.* a druggist, four Scripture readers

and pupil teachers, two relieving officers, two undertakers, a pawnbroker, a furniture broker, and a burial-club collector) were probably brought by business directly into the infected room, or became possessed of the infected bed, bedding, and clothes of the sick. Among the professions were two doctors. The families of tradesmen seem also to have suffered, in proportion to the risks incurred, from infection; for next to publicans, the most numerous victims were the relatives of provision dealers."

In addition to the clear and business-like account of the state of disease and the ravages of death in 1865 (for it is a mockery to call it a "Report of the *Health* of Liverpool") the medical officer has appended diagrams exhibiting the comparative mortality for the last three years, of that which occurs at the various periods of life, and much other valuable information deserving the notice of those interested in the health of large towns. But unfortunately we are not permitted to stop here, and to say that in the year 1865 such was the state of sanitary affairs in Liverpool.

For the week ending March 17, 1866, about two months before the outbreak or importation of cholera into the borough, the following were the rates of mortality in the various large towns of Great Britain:—

Newcastle	26 per 1,000
London, Salford, and Birmingham	30 ,,
Dublin	31 ,,
Hull	34 ,,
Glasgow	35 ,,
Sheffield	37 ,,
Edinburgh and Leeds	38 ,,
Manchester	39 ,,
Bristol	40 ,,
Liverpool	57 ! ,,

Now we think we shall have carried our readers with us to the conclusion, that Liverpool, the greatest artery of emigration, and the port into which substances are largely imported which are the best calculated to convey the germs of disease (rags picked up in the streets of the large towns of Egypt and other Eastern countries, and cotton and wool from all parts of the world), is in the state best fitted to receive, fertilize, and disseminate those germs; and it remains for us to inquire in what manner the local authorities of that important borough acquit themselves of the duty they owe to its inhabitants and to the nation.

The guardians of the public health in Liverpool are, or should be, the Town Council, and more immediately the Health Committee of that council, a body consisting of a number of well-meaning, kind-hearted gentlemen, who would, if they knew how, bring about a better state of things than now exists in the borough. The health officers are Dr. Trench the medical officer, Mr. Newlands the borough engineer, and until lately, Mr. McGowen, the deputy town clerk and the legal adviser to the Health Committee, now town clerk of Bradford. Upon these gentlemen, than whom a more enthusiastic, honest, and indefatigable trio never existed, devolved the responsibility of pulling down and improving houses unfit for habitation with the disagreeable accompaniment of turning out the tenants inhabiting them. The difficulty which they encountered in obtaining magisterial support was referred to in our former article as characteristic of the state of things in every part of the country; but now let us see how their efforts were seconded by the Council itself—for, not having any concern with local politics, we have only to deal with the Corporation as a body, and not with any of its committees or sub-committees.

About the time of the cholera outbreak, the following, as nearly as we can ascertain, was the state of affairs. To the *credit* of the corporation in the alleviation of the plague-stricken districts, we find the following items, approximately stated, but sufficiently so for practical purposes.

Since the passing of the Sanitary Amendment Act of 1864, three presentments had been made by the Grand Jury to demolish in all 485 houses. The amount which had been expended for that object was about 4,000*l.*, and it was expected that about 30,000*l.* more would be employed for the purpose.

An active member of the Health Committee brought forward a motion that 1,000*l.* should be granted for structural alterations in courts, to give them more light and air, but it was not carried (our readers may think this should go to the *debit* of the account). Small sums, however, varying from 15*l.* to 40*l.*, are occasionally voted out of "surplus capital" for the purpose.

The corporation has bought, with a view to re-sale on chief rent, for the purpose of building workmen's dwellings, 22,550 yards of land at 18*s.* per yard.

We think these are the important items, making in all, let us say, 60,000*l.* or 70,000*l.* to the credit of the local authorities of Liverpool, for what we shall call the "Reformation Account." Now let us inquire what goes to their debit in money and kind; that is to say, what money has been devoted to less necessary purposes, and what steps have been taken to *retard* sanitary progress there.

In the first place, for the benefit of the large shopkeepers and the local gentry the small item of 118,000*l.* (we are within 1,000*l.* of the mark, and *under* it) has been devoted to widening a portion of Church Street, already one of the handsomest streets in the town: of this amount 8,000*l.* was employed in law expenses.

Item No. 2 is a trifle of 250,000*l.* for a "People's Park," situated about five or six miles away from those parts of the town of which the inhabitants have most need of fresh air. Although this project was brought forward ostensibly for the benefit of the "people," it was stated at the time in the Council by a member of the Health Committee (that committee, we believe, having opposed the scheme), that it was in reality a park for the gentry, and something was said to the effect that it was intended as a kind of barrier between the poor and rich. A member of the council, a draper, who advocated the project very warmly, and who, we believe, inhabits a handsome house beyond the boundary of the intended Park, said something about the necessity of a "Rotten Row" for Liverpool, where the poor would have the pleasure of seeing the equipages and attire of the rich. About the same time a discussion took place concerning the short water-supply of the town, and the chairman of the Water Committee said regarding the Corporation Baths for the poor, "that the town could not afford water for such luxuries!" Here, then, we have two items of 368,000*l.* for widening a wide street in the town and forming a Park outside of it. And it has been stated in defence of this latter proceeding, that a good deal, if not all the "Park-money" may be recovered if properly dealt with. Just as if the same rule would not apply much more forcibly if the same money had been laid out in sanitary improvements within the borough.

But, about the time stated, the Town Council committed an act in direct opposition to the wishes of the community, as expressed in strong terms by nearly all the local papers, of whatever creed or politics, which cannot be too severely reprobated, and of which we can hardly think some of the persons concerned had seriously weighed the consequences. They virtually drove away from the town the gentleman who was not only the most willing but also the most able to deal with the great danger which has been hanging over the town so long and which threatens the country at large, we mean Mr. McGowen, the legal adviser to the Board of Health and Deputy Town Clerk.

As far as we can gather from the local press, and from reliable information which we have received, the circumstances of this proceeding were as follows:—

The Town Clerk, Mr. Shuttleworth, was compelled by indisposition to retire from his office, and amongst the local applicants was naturally Mr. McGowen, his Deputy, who had been twelve years in the service of the Corporation; of the Health Committee more particularly, and in whose favour all the local candidates withdrew. Mr. Rayner, the Town Clerk of Bradford, was the only other competitor, and when he heard how strong a feeling had been manifested in favour of Mr. McGowen he also withdrew. A powerful cabal was however formed, consisting of some leading men "on both sides of the house" (for, as we hear, party politics run tolerably high in the Liverpool Town Council), and these persons succeeded in inducing Mr. Rayner to renew his application, and under a promise that a separate office should be created for Mr. McGowen, they also induced a small majority of the council to elect their nominee, contrary to the wishes of the Health Committee, who pleaded hard for their best coadjutor, and also against the voice of the large mass of the townspeople. Shortly afterwards, Mr. McGowen was offered the Town Clerkship of Bradford, and seeing, as he said, that there was no intention to provide him with an office, he accepted it. Then followed laudation and regrets, a corporate testimonial, and after his departure (if we are rightly informed) still greater perplexity in regard to the health of the town, for immediately afterwards the cholera outbreak occurred. Many were the rumours at the time concerning the motive which induced a number of gentlemen to propose, and others to countenance this suicidal conduct. Personal animosity and cliqueism were the more generally credited causes, but it was even rumoured that the exigencies of party politics of a wider (we cannot say *higher*) nature than mere local ones had necessitated the act. Be that as it may, our readers will agree with us that it is little to the credit of the Corporation of Liverpool, and that it is a national hardship that the town and kingdom should thus be further exposed to the ravages of a virulent epidemic. To repeat the printed words of Dr. Duncan, when speaking in 1843 of the state of things which had existed in Liverpool for half-a-century, and throughout that time had rendered it, as it is to-day, the most unhealthy town in the whole country, "*inferior considerations triumphed over the public good.*"

Is it necessary that we should recapitulate the conditions which, it is agreed on all sides, are absolutely requisite for the safety of the three kingdoms, in order to show that none of those conditions are complied with in a most vital portion of the realm? Are our readers satisfied that epidemics rage in an unnecessary degree in the great aorta of our commerce and emigration—that every condition exists there for fostering those diseases, and that the local governing body should not be permitted any longer to administer this portion of its duties without higher direction and control?

We cannot think this requires any further showing. What, then, should be done? Shall Government interfere? We should say not. The Chancellor of the Exchequer, being member for that division of the County of Lancaster in which Liverpool is situated, and having a near relative in the Town Council, might be subjected to the same influences which are brought to bear upon the local members, and which impede the progress of sanitary reform. We do not for a moment mean to insinuate that the Right Honourable gentleman would be guided by such influences any more than we should suppose the members of any honourable body would knowingly allow themselves to be thus led or coerced. But occult influences are so easily brought to bear in all these matters, that it is better for local reforms to be enforced by strangers than by friends. A special Committee of the House of Commons on the whole question of the health of our large towns would of course be the alternative (and the only one, as far as we can see), and such a commission would no doubt first direct its attention to the most sickly towns—Liverpool being notoriously *the* worst. In its labours it would no doubt have the cordial co-operation of the honourable members for the borough and county, two of whom, by the way, Mr. Graves and Mr. Charles Turner, are members of the Liverpool Town Council.

Having thus explicitly, and we trust charitably, made public the sanitary state of Liverpool, its dangers to the country, and the remedy which appears to us to be the most feasible, we must defer the consideration of the health of other large towns for the present, and leave the matter in the hands of those whose duty and interest it is to watch over the public safety, and to prevent amongst our people an outbreak of pestilence similar to that which has ravaged our herds and flocks.*

II. THE NEW IRON-FIELDS OF ENGLAND.

By Edward Hull, B.A., F.G.S., of the Geological Survey of Great Britain.

It is now becoming daily more apparent that there is scarcely a geological formation—at least in England—which cannot be turned to some economic use, or is incapable of yelding some mineral substance of value to man. Whether the formation be granite, porphyry, slate, grit, sandstone, limestone, chalk, clay, or shale, all are included under the above category. The requirements of art and the progress of civilization put the earth under tribute, and however often the levy is made, the supply is certain to be ready: on the other hand, the very variety of the mineral products constantly challenge man's inventive powers to find out their uses, and in this way, more perhaps than in any other, nature is the instructor of art.

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* Since the above article was written, the Corporation of Liverpool have applied to Parliament for powers to obtain an increased water-supply. The following is the evidence of Dr. William Stewart Trench, examined by Mr. Milward: "I am Superintendent of the Board of Health at Liverpool. The death-rate last year was 36·4. The average throughout the kingdom is 22. The average death-rate in towns is 24·1. *If Liverpool had been as healthy as the average of towns, we should have saved 6,000 lives.* Last year, I brought the subject before the Health Committee, and they submitted it to the Water Committee. There is a painful want of water in Liverpool. The state of health in Liverpool in May and June was very bad, and when diarrhœa appeared the death-rate was considerably increased—very much owing to the inadequacy of the rainfall and the supply of water. There was a direct connection between the death-rate and the insufficient water-supply. *I look with great anxiety to the threatened approach of cholera, and particularly to what may occur during the months of July, August, September, and October.*"

It is an old remark, that the most useful of all our metals is the most abundantly diffused through the rocks and strata of our earth. In some parts of the world nearly pure ores of iron occur in masses of sufficient magnitude to constitute hills, or parts of mountains. This is the case in Scandinavia, parts of Central Europe, and Southern India, where magnetite assumes the proportions rather of a rock than of an ore.* In our own country, however, we have no such examples of the massive accumulation of pure iron-ore, but the difficiency is amply compensated for by the frequency of its occurrence in combination with other substances. Before entering more fully on this subject, I wish to make one or two remarks on a point of nomenclature, which it would be of advantage to adopt when speaking of the different forms in which iron-ores occur. The classification of these ores into two groups, to be called "iron-ores" (proper) and "iron-stones" respectively, will be easily apprehended by all persons familiar with the manufacture of iron; and the various modes of its occurrence. The distinction holds good for the most part, both mineralogically and stratigraphically, and is indeed often unconsciously used in commerce. Under the head of "iron-ores" (proper) might be classed those which occur either in the form of veins or lodes, and pockets, such as the red hæmatites of North Lancashire, Cumberland, and the Mendip Hills, the brown hæmatites of the Forest of Dean, South Wales, and Cornwall, and the magnetite of Cornwall, Devonshire, and Sweden. Now all these ores are amongst the richest in iron, are but slightly debased by any foreign substances, and they occur in the form of the ores of other metals, such as copper and lead, or approximately so. The "iron-stones," on the other hand, are of a more earthy character, are consequently not so rich, and partake more or less of the laminated or bedded structure of the strata with which they are associated. Under this head may be classed the black bands and clay-ironstones of the coal-measures, the iron-bearing beds of the Lias, Oolite, Greensand, and Wealden formations. There are, doubtless, some rare cases in which the ores partake of an intermediate character, but in the great majority of cases they may be arranged under one or other of these heads.

The ores which we are about to consider are of the latter description. They are essentially *iron-stones*, and occur, to a greater or less degree, in a stratified form, partaking of the aqueous origin of their associated rocks. So similar indeed are they to ordinary strata, and so little calculated to arrest attention, that for hundreds of years they had been quarried for building purposes, or even for the less honourable use of mending roads, without their metalliferous qualities having been discovered.

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* See the description of the Magnetic Iron-ore of the districts of Trichinopoly, Salem, and South Arcot, in this Journal, No. VI., p. 342.

I may here be allowed to capitulate very briefly the progress of the iron-smelting of this country to the present time. The sources from which our chief supply of iron had been procured from very early periods down to the middle of the last century were the hæmatites of Gloucestershire, South Wales, the Mendip Hills, and the iron-stones of Kent and the Weald of Sussex; the coal-measures of Salop, Lancashire, Yorkshire, and Scotland. Some of these ores are believed on good grounds to have been worked by the Romans, the fuel generally, but perhaps not exclusively, used in the process of smelting being charcoal. This material, however, became gradually scarce, and some of the writers of the last century lament the rapid destruction of the forests both of the South of England and the Midland counties, owing to the using up of the trees.* Necessity is the mother of invention, and as the requirements of iron became more extended, and the supply of charcoal diminished, it became necessary to try some other fuel. There is, as is common in such cases, some uncertainty to whom the honour belongs of having first successfully employed coal for this purpose, but it is generally admitted that Dud Dudley, after several failures, was the first to succeed in the attempt. The wasteful consumption of this valuable mineral in the process of smelting was at first enormous, but as the process began to be more generally adopted, as improvements took place in the formation of the furnaces, the use of the hot blast and other appliances were introduced, the proportion of coal employed became gradually less, down to the present day, when it may be said to have nearly reached its minimum.

The black-band and clay-band iron-stones of the coal-measures have hitherto been our chief sources of supply. These ores occur in thin layers associated with coal-seams, shales, clays, and sandstones. A few years since, however, the rich hæmatites of North Lancashire and West Cumberland were opened up, and are now very largely used, both for mixing with the former and for the manufacture of the finest pig-iron directly from the ores themselves. From this iron only Bessemer steel is at present made. The ore occurs in enormous "pockets," or irregular masses, filling chambers in the carboniferous limestone, and often only covered by a few feet of drift clay or millstone grit, while in one or two places it is quarried in open-work. Meanwhile, the process of exhaustion of the coal-measure iron-stones in some of the principal centres of manufacture was going on apace, and it must be confessed that now the *local* resources of Staffordshire, Shropshire (Coalbrook Dale), and the

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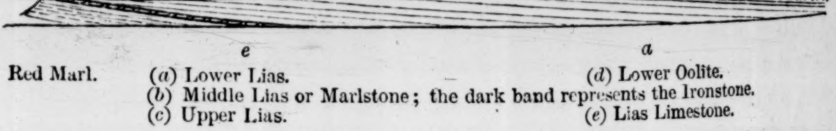
* I am informed by Mr. W. Brockbank that there are still two or three places in Great Britain where charcoal is used in smelting under peculiar circumstances, and for the production of a very high class of pig-iron.

Glasgow districts are rapidly diminishing, while every year the demand for iron is increasing. How this demand was to be met, without drawing largely on the resources of foreign countries, is a problem which received its solution just at the time when it began to occupy men's minds. The solution was the discovery of those "New Iron-fields of England" which occupy a broad belt of country traversing our island almost from the shores of the English Channel to those of the German Ocean.

This belt is formed of a range of hills with scarped ridges, and longitudinal valleys, rising to the eastward above the plains of the central counties. In this range are included *geologically* the Cleveland Hills of Yorkshire and the Cotteswold Hills of Gloucester and Somerset; but it must not be supposed that the strata are equally rich in iron all along the entire range, although the representative formations in which the iron occurs may be present throughout. This range at several points both in Yorkshire and Gloucestershire reaches elevations exceeding one thousand feet above the sea, and terminates in the coast-cliffs of Saltburn on the north, and those of Lyme Regis on the south. It is composed of Jurassic formations,* or speaking more definitely, the upper members of the Lias and the lower members of the Oolite series. From the base of the range the Lower Lias and New Red Marl stretch away in slightly undulating plains towards the west, and with some slight modifications the general succession of the strata, and the form of the hills as they occur in Yorkshire, Lincolnshire, Gloucestershire, and Somersetshire, may be expressed as in the following diagramatic section.†

FIG. 1.—DIAGRAMATIC SECTION, TO ILLUSTRATE THE POSITION OF THE LIASSIC AND LOWER OOLITIC SERIES.



Red Marl. (*a*) Lower Lias. (*d*) Lower Oolite.
(*b*) Middle Lias or Marlstone; the dark band represents the Ironstone.
(*c*) Upper Lias. (*e*) Lias Limestone.

There are two positions in the above section where the ironstones occur, the lower being at the top of the Middle Lias, or Marlstone, the upper at the base of the Great Oolite. This latter, however, is almost exclusively confined to Northamptonshire, and by far the most important member is the Middle Lias iron-stone of the counties of York, Lincoln, and Oxford. The range also touches the counties of Rutland, Leicester, and Warwick, in all of which iron-stone occurs, but it is as yet unrecognized, practically at least, in the Coteswold Hills and in Somersetshire.

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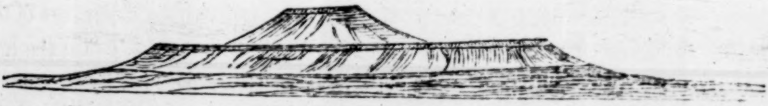
* "Jurassic"—a good term—taken from the Jura range on the borders of France and Switzerland, whereby to include the Liassic and Oolitic formations under one name.

† The main difference is, that in Yorkshire the Great Oolite rests on the Upper Lias, in Gloucestershire it is replaced by the Inferior Oolite.

The iron-stone is the upper member of the Marlstone, or Middle Lias formation, the lower consisting of sandy shales, or fine laminated sands with bands or nodules of iron-stone. Where the upper member ceases to be sufficiently rich in iron to be deemed an iron-stone, it occurs in the form of a hard calcareous grit, generally very full of its characteristic fossils, such as: *Rhynchonella tetrahedra*, *R. variabilis*, *Terebratula punctata*, *Pecten æquivalvis*, *Nautilus truncatus*, *Ammonites margaritatus*, and *A. spinatus*. As it is overlain directly by the soft shales of the Upper Lias (or "alum shale"), these in the process of denudation have often been washed away, leaving platforms of the rock projecting from the flanks of the range, or forming isolated flat-topped hills rising above the general surface of the country. Oxenton Hill in Gloucestershire is a good illustration of the latter case; and the section above (Fig. 1) represents the former.

FIG. 2.—A GLOUCESTERSHIRE HILL.



In the above figure the upper conical portion of the hill is composed of Upper Lias, capped by Oolite, the platform on which it rests being Marlstone, or Middle Lias.

The oolitic iron-stone of Northamptonshire, and a few other places, belongs to the lower portion of the Great Oolite, called by the Geologists of the Government Survey "the Northampton Sands,"* and is very irregular in its distribution, although occupying on the whole a large tract of country. These sands rest directly on the Upper Lias Clay, and are overlaid by the white limestones which form the upper member of the Great Oolite. The iron-stone is found in irregular beds, sometimes reaching a thickness of twelve or fourteen feet, and within a mile or two thinning away altogether. There is a remarkable instance of this near Blisworth, for the iron-stone, which occurs plentifully at the northern side of the railway tunnel, disappears altogether at the southern end. The ore is a hydrated oxide of a rich rusty-brown colour, of high specific gravity, and silicious. When reached at some distance underground, where it has been protected from atmospheric influences, the colour is found to be olive-green, but these portions are generally rejected by the quarrymen. It is extensively worked at Blisworth, Gayton, Glendon, Maidford, Wellingborough, and Duston. In all, there are about thirteen quarries and four furnaces in blast in Northamptonshire, besides which, large quantities of the stone are sent by canal and rail into South Staffordshire, and even South Wales. The quantity of ore raised in 1864 was 335,787 tons, of the value of 84,761*l*. The furnaces are situated at Wellingborough and Weedon.

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* See memoirs 'On the Geology of Parts of Northamptonshire,' by Mr. W. T. Aveline, F.G.S.

Having thus described the geological position of both the Oolitic and Liassic iron-stones, and also the special characters and districts where the former of these occurs, we shall now return to the consideration of the latter and more important source of supply from the New Iron-fields, and trace its course from Yorkshire in the north to Oxfordshire in the south.

The Cleveland Hills, the cradle of the new iron trade, form a range of very picturesque hills, terminating northward in a line of escarpment, ranging along the valley of the Tees and in lofty cliffs lining the coast of the German Ocean from Saltburn to Whitby. Inland, the escarpment bends round to the southward, opposite Middlesborough, and stretches in an indented line to the banks of the Humber, near Hull. The northern portion of the hills is intersected by deep valleys, some entering from the coast, as those of Skelton Beck, Kilton Brook, Easington, and Rondsley Brooks. Others enter from the land side, as those of Guisborough and Kildale. The summits of the ridges between these valleys are capped by Great Oolite, below which is the Upper Lias shale, forming the upper slopes down to the Marlstone, or iron-stone bed, which juts out along the flanks of the valleys about half-way from the bottom. The importance of these valleys in laying bare the outcrop of the iron-stone, and allowing it to be extensively worked without the labour and cost of mining, will be readily appreciated. Already, numerous tramways and branch lines connecting the mines with the North Yorkshire, Cleveland, and Stockton and Darlington Railways, as well as with special smelting-furnaces, have been constructed. Like the Cotteswold Hills, in Gloucestershire, the Cleveland Hills may be regarded as an elevated table-land, so deeply indented and cut up by valleys, that its original form is almost obliterated, and it now presents the appearance of an assemblage of ridges and ramifying valleys, with little appearance of order or system in their arrangement. This, however, is only apparent, as the upper surface of the ridges corresponds to an imaginary plane sloping gently towards the south-east. The general vertical section of the formations as they occur near Saltburn is as follows:—

		Thickness in Feet.
GREAT OOLITE . . .	Yellowish sandy Oolitic Freestone . .	30
UPPER LIAS . . .	Dark blue bituminous Shales . .	150
MIDDLE LIAS, OR MARLSTONE	1. Nodular Iron-stone, with a thin band of Iron Pyrites	3 in.
	2. Solid greyish-green Iron-stone . .	12 ft.
	3. Sandy and rusty Shales . . .	12
	4. Second bed of Iron-stone, resembling "clay-band," with 30 per cent. of Iron	3
	5. Sandy Shales and Sandstone . .	80
LOWER LIAS . . .	Blue Shales and Clay . . .	—

The upper bed of iron-stone is alone worked, and this is done either by mining from adits driven into the sides of the hills, or by open-work, as at Hob Hill Quarries. It is of a greyish-green colour, finely oolitic in structure, and weathers into rusty concretionary bands and nodules. Some of the mines are on a very extensive scale. At Eston and Up-Leatham mines, the iron-stone rock dips into the hill from the outcrop at 1 in 15, becomes horizontal under the central part, and rises again to its outcrop at a distance of several miles to the southward in the valley of Guisborough. The mode of working is by galleries six yards wide, walls being left of equal width to support the roof, until the whole of the property is opened up, when these will be recovered by working backwards. A thorough system of drainage and ventilation is established, and the stone is drawn up in trucks to the mouth of the adits by stationary engines, and tipped over into the wagons of the Stockton and Darlington Railway, in which it is carried direct to the furnaces. In general, it is considered that three tons of the raw ore produce one ton of pig-iron.

The following are the proportions of fuel, flux, and stone in use at the works of Mr. B. Samuelson, M.P., in 1864, since which time the proportions of fuel have been considerably reduced:—

3 tons of raw ore, or 2 tons 8 cwts. calcined ore	one ton of grey forge pig.
24 cwt. coke	
12 cwt. limestone	

The banks of the Tees, which are nearly flat for some distance from the river, and then rise with a gradually-increasing slope to the base of the Cleveland Hills, form an admirable site for the erection of smelting works and forges on the largest scale. Along the southern shore the Stockton and Darlington Railway has been carried to Saltburn, and in one direction serves to supply the ore, and in the other the fuel from the Durham coal-field. No one can drive along this line from Redcar to Stockton, and pass in succession the Titanic works which have been erected and are still rising along its course, without being impressed with the prodigious energy displayed by the iron-masters of this district; for it is to be remembered that the whole of these works have sprung into existence within the last sixteen years. Middlesborough is the metropolis of this trade, and the chief port for the shipment of the iron, both in its raw and manufactured states. Other smelting and manufacturing works are also erected on the northern shore of the Tees, and in 1865 the whole district comprised 105 furnaces in blast, smelting very nearly one million tons of pig-iron.

The Cleveland iron-stone becomes thinner, and is leaner towards the south, but as the quality of the iron is good, it is extensively worked in the valley of the Esk, near Whitby, the new line from

Picton to Whitby giving access to the Durham coal-field. The stone is also largely worked along the sea coast from Whitby to Redcar, and is shipped chiefly to the iron-works on the Tyne.

The Rosedale iron-stone is the richest of all the Cleveland ores. Its colour is dark olive-green, it has a high specific gravity, is compact, magnetic, and polar. It contains from 35·94 to 49·17 per cent. of metallic iron, and is smelted by itself at Ferry Hill, but is chiefly used for mixing with the other ore in the Cleveland furnaces. In 1864, nearly 300,000 tons were quarried and carried to market by a special branch railway. Continuing the survey southward, we find the iron-stone of the Lias cropping out in the direction of Northallerton and Thirsk, and trending thence in a south-easterly course by Easingwold, Hulton, and Market Weighton to the Humber. The dip is here a little north of east, and there are extensive tracts where it has not as yet been opened out.

On crossing the Humber and entering Lincolnshire, we again get on the track of the same bed at Saint Hope and Frodingham, in the northern part of the county, and from thence we can trace it southwards along a low range of hills rising to the eastward of the valley of the Trent. At the Frodingham iron-furnaces, built on the outcrop of the iron-stone, which is here twelve feet thick, there is a very fine section in the railway cutting, which fully exposes the relations of the iron-stone to the underlying Lias. At the Trent Iron-works there are three furnaces, and here the rock is actually twenty-nine feet in thickness! Further south, where the North Lincolnshire Company are erecting two very large furnaces, the rock is of similar thickness.

The mode of working in this district is very simple, and has been described to the writer by Mr. W. Brockbank, F.G.S., as follows:—As the iron-stone lies exposed on the upper surface of the hills, the furnaces are erected upon it as a foundation, and the inclines for raising the minerals to the tops of the furnace are carried down to the base of the iron-stone, where the wagons are filled and hoisted directly to the surface for calcining. As the workings progress, the hollows are partially filled with slag, and the soil is replaced, so that the land becomes fit for agricultural purposes or planting, and is not disfigured by the hideous mounds of clay and refuse, such as are to be seen in many of the older iron districts.

The iron production in Lincolnshire is only as yet in its infancy, about 30,000 tons being the quantity smelted during the past year; but there can be no doubt but that the trade is destined largely to increase. In the first place, the metal produced is of a quality superior to that of the Cleveland district, which is owing probably to the presence of oxide of manganese largely in the rocks, and its more calcareous nature. Some beautiful specimens of specular pig-iron have been produced at the Frodingham furnaces. The district is also favourably placed with reference to its geographical position: its distance from the Yorkshire coal-field is small, so that while it is within easy reach of fuel, it can send large quantities of the ore into the Yorkshire coal-field for mixing with the argillaceous iron-stone, and this is now practised to a large extent. For shipment it is being placed, by the construction of new lines, in communication with the ports of Goole and Grimsby, while it is also favourably situated for sending supplies into Staffordshire and other inland markets. The metal possesses the qualities of extreme fluidity when melted, and is tenacious in a manufactured state; so that it answers well for hoops and boiler-plates. For general purposes, however, it is improved by the mixture of either Cleveland or hæmatite pig-iron.

The Middle Lias of Northamptonshire has not as yet (as far, at least, as I am aware) yielded iron-stone. The formation is doubtless there, lying about 120 feet under the Northamptonshire iron-stone, which, as already stated, occurs at the base of the Great Oolite. The richness and abundance of this latter ore have probably diverted attention from the former, for it ought not to be forgotten that these Jurassic ores do not force themselves on men's attention, but have rather to be sought for. As I have already described the oolitic iron-stone of this county, I shall therefore pass on to the consideration of the Oxfordshire iron-stone, at the southern extremity of our district.

The iron-field extends over a hilly tract of ground, extending from Edge Hill, near Banbury, on the north, to the valley of the Evenlode, near Charlbury, on the south, near which place it has as yet alone been worked.* The ore belongs to the Middle Lias, and is similar in appearance to the Lincolnshire, and sometimes to the Cleveland stone. It consists of olive-green oolitic rock, more or less calcareous, and weathering rusty-brown. At Fawler the thickness is twelve or fifteen feet, and this may be taken as the average over that part of the field where the iron-stone is richest. Towards the western escarpment of the hills, overlooking the vale of Moreton, the rock decreases both in thickness and quality as an iron-stone; as it does also to the eastward, along the valley of the Cherwell, as far south at least as Aynho. Around Bloxham, Deddington, Great Tew, Hook Norton, and Swalcliffe, it appears to be of good quality, and generally forms nearly level terraces, intersected by narrow valleys—a position peculiarly adapted for economical working and drainage. New lines of railway are now being constructed across the richest portion of the district, placing it within reach of South Wales and South Staffordshire; and, judging from the experience of Northamptonshire and the adjoining county, it seems probable that a few years hence furnaces will be erected in this district. The quality of the pig-iron produced, as tested by the trials from the Fawler quarries, has been pronounced good, though the yield is variable, as the rock is often superabundantly calcareous, and the average yield of metallic iron will probably not be found to exceed thirty per cent.; on the other hand, it will require little or no admixture of limestone for fluxing.

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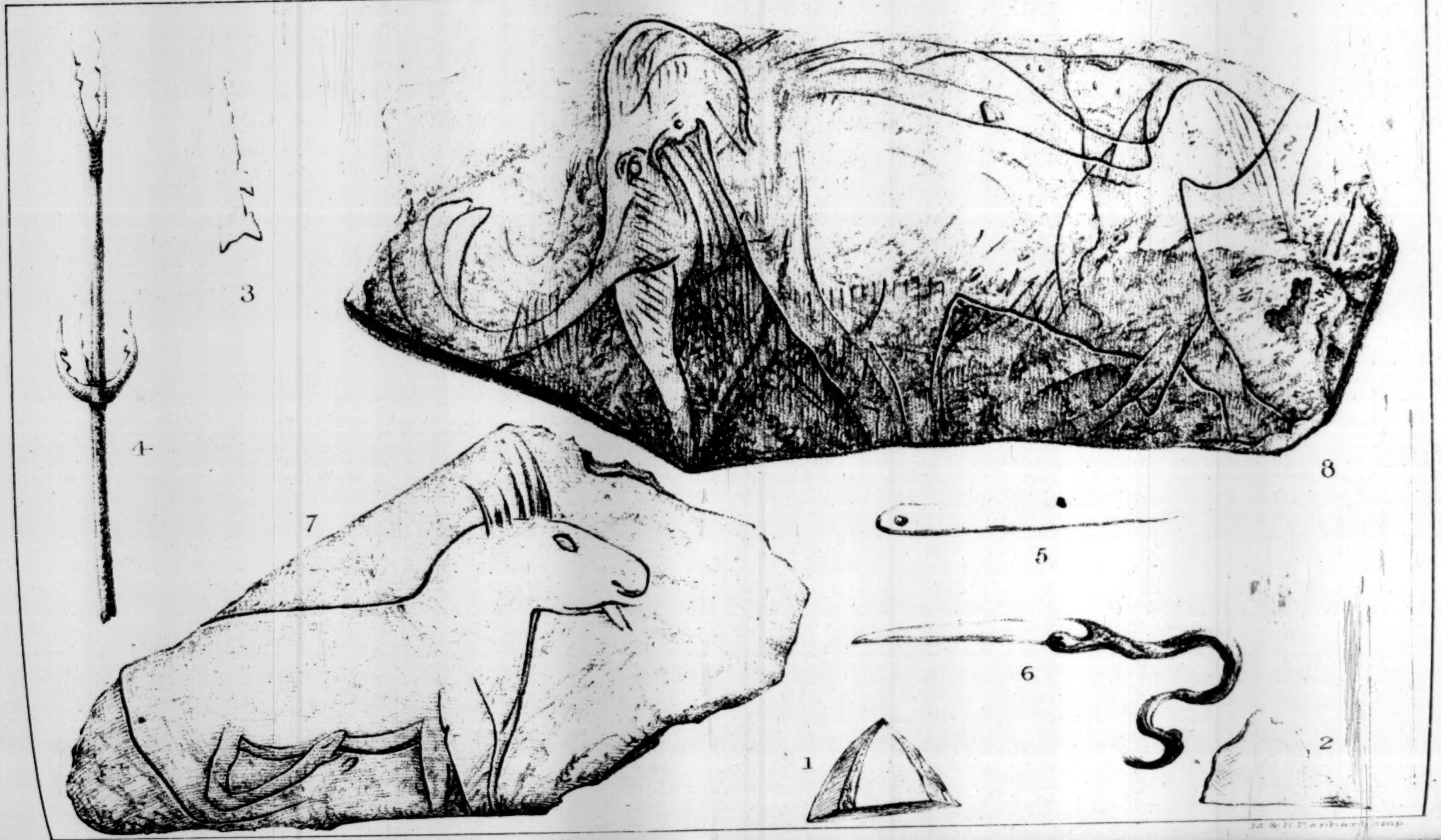
* At Fawler quarries, the yield of which, in 1864, was 6,666 tons. The iron-stone has also been worked at Steeple Aston.

The rapid increase of iron-smelting in the new districts may be judged by the following statement:—We learn from the 'Mineral Statistics of Great Britain,' compiled by Mr. R. Hunt, F.R.S., that in 1864 the total quantity of pig-iron smelted in the United Kingdom was 4,767,951 tons, from 10,064,890 tons of ore. Of this, the North Riding, Lincolnshire, and Northamptonshire produced 431,929 tons. What the total produce for 1865 may be we are not yet informed, as the statistics for this year have not yet been published; but we shall probably not be far wrong if we estimate it at 6,000,000 tons of pig-iron, of which the Cleveland district, Lincolnshire, and Northamptonshire will have yielded 1,100,000 tons. The proportions therefore of the yield from the New Fields to that of the United Kingdom will have been, in 1864, nearly one-tenth, while in the following year it will have been more than one-sixth of the whole. Considering the rapidity with which new furnaces are being erected in these districts, I shall not be surprised if it should turn out that in the present year the proportion will be one-fourth of the produce of the entire kingdom, and this is exclusive of the large quantities of iron smelted from ores sent into other iron districts.

We have now completed our survey of the New Iron-fields of England through a tract of country ranging from north to south for a distance of 200 miles. The survey might be still further extended if we included the Wiltshire ores, which are of limited extent, and belong to a still higher geological horizon. Enough has probably been stated to show the enormous extent of our resources in this mineral, which is sufficiently abundant to use up the whole of our available coal for its conversion into metallic iron. As regards the quality of the iron produced, it is confessedly inferior to that derived from the clay iron-stones and black bands of the coal measures, still more to that from the hæmatites of Ulverstone and Furness; but for ordinary purposes and for mixing with the finer classes, it is of great value. It is, moreover, supplying the enormous demand of the present generation; and, looking to the future, there can be no question that the Middlesborough district is destined to have no rival in any part of the world.



E. M. Williams F.L.S. F.Z.S. lith.

M & N Hanhart imp

IMPLEMENTS AND SCULPTURES OF THE FLINTFOLK.

III. ON THE HABITS AND CONDITION OF THE TWO EARLIEST KNOWN RACES OF MEN.

By W. Boyd Dawkins, M.A. Oxon, F.G.S.

In this age of steam-engines, and electric-telegraphs, and printing-presses, surrounded by all the appliances of modern civilization, with the hum and stir of commerce in our ears, and with our eyes accustomed to the rich cultivated fields, or the densely-populated towns, we find it very hard to realize to ourselves the England or the Europe of 500 years ago, when all these things were not, and when the habits of life which these things have naturally developed, were altogether different. So difficult is it, that with all the old chronicles at hand to furnish a true picture of the life and modes of thought of those times, Lord Macaulay is the only English historian who has attempted to give them even in outline. Still further back the materials for the social history of Western Europe grow more and more scant, and anterior to the time when the Romans conquered Gaul and obtained a foothold in Germany, there are none whatever. Of the social condition of the people who dwelt in Britain, from Cæsar's landing down to the invasion of the Saxons, we know historically next to nothing; the accounts left by Tacitus and other writers recording merely the movements of the Legions, and the establishment and maintenance of the Roman Imperium, with but incidental notice of the habits and customs of the vanquished. But where History is silent, Archæology steps in and wrests from the "speechless past" evidence of the existence, and an outline of the habits of races of mankind that have disappeared. The caves and rock-shelters of Dordogne afford the first traces of the dawn of sculpture and engraving in Western Europe; the tumuli of Scandinavia, Germany, France, and Britain rival the tombs of Etruria in the knowledge they yield of their makers; the Pile-dwellings of Switzerland tell their own story, as well as the buried cities of Herculaneum and Pompeii. In a review of history we realize that nations, like individuals, die, and that from time to time great migrations have destroyed the very existence of certain European peoples. In the Pre-historic times we also see that tribe drove out tribe, and race succeeded race, each bringing with it peculiar customs and habits. In both there is a gradual progress traceable in the arts and sciences, and in all that now makes life worth the living. In carrying man back into the most remote past to a point where Archæology dies away—so to speak—into Geology, we shall be compelled to acknowledge the truth of the saying of the great Pascal, that "the entire succession of men through the whole course of ages must be regarded as one man always living and incessantly learning." The very first man who lifted himself above the beasts of the field by the discovery that a sharp stone or a snare would subserve the purpose of obtaining food better than his unarmed, unaided limbs, laid the foundation of our arts and sciences. From it our culture and knowledge sprang, a giant tree now, but whose development in the glorious future will bear to its present growth the same relation which that growth does now to the parent germ. As the habits of man are essentially dependent upon external physical circumstances, we shall have occasion incidentally to touch also upon them.

The labours of the Scandinavian antiquaries, and especially of Professor Worsaae,* have proved that Pre-historic remains in their country fall naturally into three distinct classes, indicating, if not distinct race, yet certainly different habits and modes of life—first, those of the Stone age, in which the use of metals was unknown; secondly, the Bronze age; and thirdly, the Iron age, in which man acquired a mastery over those metals, and employed them for his various needs. This classification has been found to hold good throughout Europe. The first of these divisions again, that of the Stone, has been subdivided by the French and English archæologists, and for the earlier portion Sir John Lubbock has proposed the term Palæolithic;† for the later the Neolithic age. The introduction of iron did not exclude the use of bronze, nor did the latter drive out the use of the ruder stone. Thus I obtained from a Romano-British burial-ground at Hardham, in Sussex, flint flakes, and a bronze fibula, while some of the oaken coffins were strengthened by iron nails. It is the shape and fashion of the implements and weapons, and not the material only, that are a safe guide to the relative Pre-historic age. We purpose to take the earliest of these—the Palæolithic, and to sketch the habits and condition of the two races of men who lived at that time, the Flint Folk and the Reindeer Folk, and then to trace as briefly as may be the progress of man down to the borders of history.

The gravel-beds of France and England, and the bone caverns of these two countries, and of Belgium, have afforded the earliest known traces of man upon the earth. The original discoveries of M. Boucher de Perthes, at Amiens and Abbeville, followed up by the cautious energy of Mr. Prestwich, F.R.S., prove that man co-existed with the fossil Mammoth and woolly Rhinoceros on the banks of the Somme at a time when it flowed at a much higher level than at present, and when the relations of hill and valley were altogether different in that district. The labours of the latter, and of Mr. Evans, F.R.S., have resulted in the proof that the same race of men lived in Britain from Suffolk on the east as far south as the coast of Hampshire. My own discoveries in Wookey Hole Hyæna-den extend their range into Somerset; those of Mr. MacEnery in Brixham into Devonshire; and lastly, those of Dr. Falconer in Pembrokeshire into South Wales. Throughout the whole of this area the same types of flint implements and weapons prevail. A splinter of flint afforded the only cutting edge they possessed; a mass of flint rudely chipped into a point was their only boring tool; large thick rudely-fashioned "spear-heads" their principal weapon. The so-called "sling-stones," either intended for use as missiles, or imbedded in gum, or bound round with withes, as axes, and some pointed masses of flint which may have been used for digging, comprise the list of their remains from the gravel-beds. In the Hyæna-den, at Wookey Hole, I had the good fortune to find, besides the ordinary forms, a small oval, leaf-shaped lance-head [see Figs. 1, 2, 3, 4, p. 336], an arrow-head of chert [Plate, Figs. 1, 2], a bone arrow-head, and a small-pointed bone which may have been a needle. The calcined bones on the floor prove that the use of fire was not unknown, and that the cave was inhabited. The evidence afforded by this scant list of the implements and weapons proves that the race of men who used them were savages of the very lowest order, unacquainted with the art of spinning or of making pottery, and living on the fruits of the chase without the aid of the dog. Those who dwelt in the plains of Somerset were acquainted with the use of the sling and the bow, and tipped their arrows with chert and bone. The ashes found at the mouth of the cave at Aurignac and at Wookey Hole prove that fire was known in that early epoch.

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* 'Primeval Antiquities.' Worsaae. Translated by W. J. Thomas. London, 1849.

† 'Pre-historic Times.' London, 1865 παλαῖος = old, λίθος = stone, νέος = young, λίθος = stone.

If the condition of man then differed from that of man now in Western Europe, still more did the physical aspect of Europe differ from its present aspect, in its temperature, its animals, and its area. In those early days England formed part of the mainland that stretched out far into the Atlantic. Glaciers descended from the mountains of Wales, the Lake-district, and Scotland, and the winter cold was sufficiently intense to form ice on the rivers thick and strong enough to transport great stones, which now we find in numerous places dropped among the fine gravels in their ancient beds.* In the spring, when the winter accumulation of ice and snow melted away, the lower grounds were covered by extensive floods similar to those which now take place in Canada, the Hudson's Bay Territory, and Siberia. The large areas of silt which they have left behind, prove their former extent; as, for example, that stretching from Brighton at least as far as Portsmouth. The land was covered with dense forests of oak, beech, alder, and Scotch fir, through which the rivers cleft their way to the sea, bearing the carcases of Reindeer or Red-deer, huge Mammoth or woolly Rhinoceroses, or now and then the Musk sheep, and either dropping their bones in various places in their course, or leaving them col-

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* See "British Pleistocene Mammalia," by W. Boyd Dawkins and W. Ayshford Sanford. Introduction, Sec. xi., 'Palæont. Soc.,' 1866.

FIGS. 1–4.—FOUR VIEWS OF A FLINT IMPLEMENT FOUND IN THE HYÆNA-DEN AT WOOKEY HOLE, NEAR WELLS.*

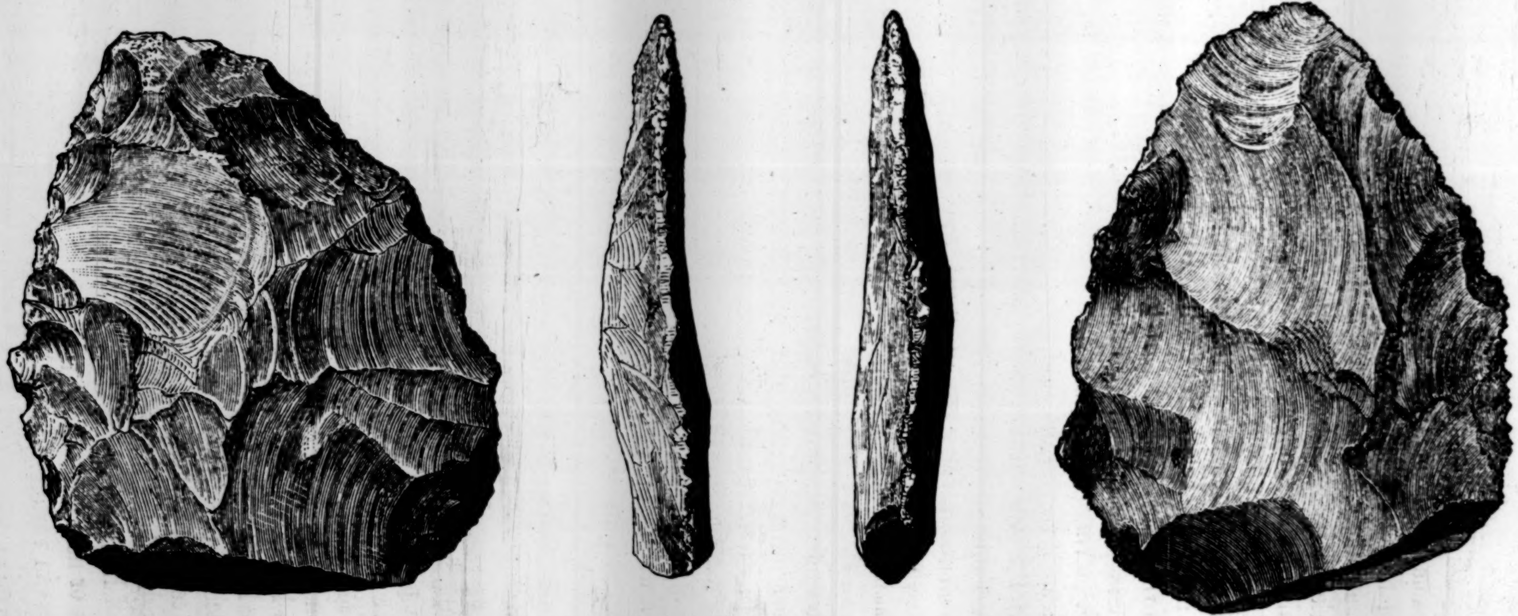

Fig. 1. Fig. 3. Fig. 4. Fig. 2.

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* Reprinted from the original blocks of vol. xviii. of the 'Quarterly Journal of the Geological Society,' by permission of the Council of the Society.

lected together by the current, as at Ilford in Essex. The Hippopotamus disputed with the Beaver and the Otter the sovereignty of the rivers. In the forests dwelt two species of extinct Rhinoceros, the Bison and the Urus, the Irish Elk and the Horse, and afforded food for the Wolves, the gigantic Cave-Lion and Cave-Bear, the Cave-Hyena and the Glutton.

On such a scene as this man appears for the first time armed with the rudest weapons of flint, chert, and bone. Exposed like the beasts to the vicissitudes of a climate far more severe than that now obtaining in the same area, living like the Hyænas in caves wherever he could find them, sheltered from the cold where there were no caves by a rude hut, probably little better than the lair of a wild beast, preying on the wild animals around him, he fought for dear life itself with the great carnivora. Separated from the beasts by the possession of reason, he had already mastered the use of fire, and armed with the bow, the spear, and the sling, made good his foothold in the Fauna of Western Europe.

The contents of the cave of Aurignac, examined by M. Lartet in 1860, inclined him to the belief that the ancient folk who used the implements found both within and outside the cave were contemporary with the Mammoth and woolly Rhinoceros, that the human skeletons found were interred at a time when the extinct Pleistocene mammalia lived in France, and that some of the animals, and especially a young Rhinoceros, had been eaten at the funeral feast.* If, indeed—to quote the classic words of Sir Charles Lyell —"the fossil memorials have been correctly interpreted—if we have here before us at the northern base of the Pyrenees a sepulchral vault with skeletons of human beings consigned by friends and relatives to their last resting-place—if we have also at the portal of the tomb the relics of funeral feasts, and within it indications of viands destined for the use of the departed on their way to a land of spirits; while among the funeral gifts are weapons wherewith in other fields to chase the gigantic deer, the cave-lion, the cave-bear, and the woolly rhinoceros—we have at last succeeded in tracing back the sacred rites of burial, and more interesting still, a belief in a future state, to times long anterior to history and tradition."† When, however, it is considered that the cave was discovered eight years before it was scientifically examined, and that the human skeletons found therein by the discoverer, a workman named Bonnemaison, were removed and buried in the cemetery of Aurignac, where they cannot now be found, the contents of the cave being thus disturbed, the inference that the skeletons are of the same age as the extinct mammals, and of the flint and bone implements, seems to be faulty. The *gisement* of the skeletons rests upon the hearsay evidence of what occurred eight years previously; no person interested in the problems concerning the human race that have arisen since 1852 having so much as seen them. Had indeed the Palæolithic savage been in the habit of burying his dead in caves, we should not be seeking in vain for perfect human crania unequivocally of that early date up to the present time; some trace of such interment would surely have been found in the numerous caves explored in France, Germany, and Britain. While therefore it is clear that Aurignac was used for a place of sepulture at some time or other, the inference drawn by the eminent French Zoologist, M. Lartet, and endorsed by the great authority of Sir Charles Lyell,* that it was so used at a time when the great extinct mammalia dwelt in France, does not legitimately flow from the facts adduced. We are therefore still in ignorance of the mode in which the savages of those days disposed of their dead and as to their belief in a future state.

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* 'Ann. des Mines, Zoologie,' t. xv., p. 177.

† 'Antiquity of Man,' pp. 192-3. First edit., 1863.

Thus scant is our knowledge of the earliest known men, the Flint Folk *par excellence*, a race that is as truly fossil and extinct as the Mammoth and woolly Rhinoceros with whom they lived.† To M. Lartet and the late Mr. Christy we owe the proof of the existence of a second race of men in the South of France, in the Department of Dordogne, in the valleys through which flow the Vezère, the Dordogne, and their tributaries. They dwelt in caves and under sheltering rocks, and accumulated around their dwellings the remains of the animals they ate, and vast quantities of the implements and weapons they used. In all the caves and rock-shelters except one, the remains of the Reindeer were most abundant, and evidently constituted the chief food of these savages of the Dordogne, who may therefore be conveniently termed Reindeer Folk, in contradistinction to the Flint Folk described above. The presence of the Mammoth and Cave-lion (the remains of which were few) in the refuse-heaps, proves that the age of the Reindeer Folk was that of the great extinct Pachydermata, while the occurrence of the Musk-sheep and Reindeer, animals confined to the cold regions of the North, indicates the arctic nature of the climate at that time in France. The implements are of a higher order and denote a higher degree of civilization than those of the Flint Folk.

The lance-heads, however, from the cave of Moustier are of a different fashion to the rest, and approximate, as M. Lartet observes, to those found at Amiens and Abbeville, and possibly belong to the same age as these latter. This is rendered more probable by the exact agreement of some of those from Moustier with the figure of one from Wookey Hole delineated above (Figs. 1–4. p. 336).‡

A list of the implements and weapons comprises lance-heads, arrow-heads, scrapers, flakes, and awls of flint; hollowed stones which may have been used for mortars or for obtaining fire by friction; sundry ornaments made of bone, antler, and teeth; a whistle made out of the first phalanx of a large stag; arrow-heads, spoons, and needles made out of bone or antlers. One of the arrow-heads cut out of the antler of a reindeer is remarkable for the alternate barbs and for the grooves on their surface, which may have been intended to contain poison. An implement from the same cave [Plate, Fig. 3], made of the same material, with the barbs on one side, was probably a fishing or fowling spear. The most remarkable remains, however, by far, are the figures of animals engraved upon stone, antler, bone, or ivory, the earliest traces of sculpture known in Western Europe. A slab of schist from Les Eyzies bears the outline of a deer; the lines, however, are too confused for specific identification. The rock-shelter of Laugerie-basse has furnished an outline of the hinder quarters of a large ox, boldly and skilfully engraved on the palmated antler of a reindeer. On a second fragment of reindeer antler the ancient artist has depicted the figure of a horned ruminant, probably the Bouquetin, of which the remains were abundant, and as he had no room to draw the hindlegs in their natural position, he doubled them forwards until the hoofs touched the animal's belly, and thus completed the whole beast. [Plate, Fig. 7.] Other fragments of antler from the same locality were fashioned into ornamented spoons or marrow-scoops; and in one case, a reindeer kneeling on his fore-legs, with eyes, ears, antlers, and tail most distinctly cut, formed the handle of an implement of some kind.

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* 'Antiquity of Man,' p. 181. First edit., 1863.

† 'Revue Archéologique,' 1864.

‡ In 1864 I had the good fortune to find an implement agreeing exactly with the two mentioned above, on the surface of a gravel-bed near Faversham. It is now in the collection of Mr. John Evans, F.R.S.

From the rock-shelter of La Madelaine has been obtained most remarkable and unlooked-for evidence of the co-existence of man with the mammoth in a fragment of fossil ivory [Plate, Fig. 8], bearing upon it the well-defined figure of the extinct species of Elephant to which it belonged.* The artist has given to it not only the tusks with eccentric curvature, which are so common in the drift gravels, but also has marked in a most unmistakable way the long hairy mane which we know, from the discovery of the frozen mammoth carcases in the North of Russia, characterized that extinct animal. This specimen, therefore, is most important, not only as an example of the early dawn of art, but also because it stamps the age of the artist to have been that of the Mammoth.

Human teeth and bones were also found in both the caves and rock-shelters, which were in precisely the same state of preservation as the bones of the animals which had been used for food, and probably owe their presence to the same want of care for the dead among the Reindeer Folk as is now exhibited by the Esquimaux. M. Lartet, however, hesitates to relegate the human remains to the age of the Reindeer: "D'abord parce qu'il est peu vraisemblable que les aborigènes de cet âge, que nous avons pu voir dans une station plus ancienne, à Aurignac, professer une sorte de culte pour les morts, aient enseveli un des leurs dans le lieu même ou ils mangeaient; ensuite, parce que l'on n'a aperçu auprès de ces débris humains aucuns des accessoires habituels et à signification symbolique que l'on retrouve jusque dans les sépultures les plus anciennes des temps primordiaux."* These two reasons seem to me to be invalidated by the equivocal evidence afforded by the cave of Aurignac. As, however, the human remains in the cave of Eyzies and the rock-shelter of La Madelaine were found *in situ* by experienced observers, the evidence for their contemporaneity with the Reindeer seems to be as good as that afforded by the bone of any other animal found.

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* 'Ann. des Sciences Naturelles.' 5^{e} ser., t. iv., 6 cahier.

These remains give us a most vivid picture of the habits and mode of life of the time. The great Carnivora had not yet disappeared from Western Europe, and of the great extinct Pachyderms the Mammoth was sufficiently familiar to the eye of the artist to be faithfully engraved. Herds of Reindeer, along with the Horse and the Red-deer, wandered through Central and Southern France. The great Arctic Musk-sheep and the Antelope Säiga of the Siberian steppes were occasionally killed by the Reindeer Folk. We can almost see the hunter returning to his cave, or rock-shelter, bearing upon his shoulders the Reindeer that he had slain, or portions of a Bison, or Urus, or Horse (for they were cut up where they fell), or with fish from the Vezère or Dordogne, or with birds that he had snared or speared, to be hastily cooked and greedily devoured by his family and friends. We can see him clad in skins perpetuating the remembrance of the chase by engraving on antlers, or bones, or stones the figure of a fish, a Red-deer, Horse, Bouquetin, and even of a Mammoth, or preparing skins for clothing with the rude flint scrapers, or sewing them together with the bone needles. And we can see him chipping his rude spear-heads, knives, and scrapers, and all his edged tools, out of a block of flint, and the chips he struck off, and the flint core he threw away, are still where they fell, on the heap of split bones, ashes, and broken implements upon which he dwelt. He was unacquainted with the art of making pottery or of spinning; he never ground his implements or weapons, and was unaided by the dog in hunting. Yet, even in this poor savage we find an idea that in the time which has elapsed between his sojourn in France and our own day has borne the most glorious fruits. The idea of representing familiar objects has developed, on the one hand, into the marvellous works of a Phidias and a Raphael; on the other, into the invention of hieroglyphics, of the alphabet, and of printing.

This early people seem to have been a different race to the Flint Folk, because, although both lived very much under the same physical conditions, in no case are their implements or weapons found together. Possibly the Reindeer Folk may have dwelt in one area at the same time that the Flint Folk inhabited another; but there is no evidence of their living in the same district at the same time. The more varied forms and the higher finish of the weapons and implements of the Reindeer Folk, as compared with those of the Flint Folk, make it highly probable that the former were not only the more civilized, but also the more modern of the two Palæolithic races.

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* See 'Revue Archéologique,' 1864.

The question who were the Reindeer Folk may be answered with some approximation to the truth by a comparison of their implements and their habits with those of savage tribes living under the same or similar circumstances. A comparison of the scraper of the Reindeer Folk [Pl. 1, Fig. 9] of M. Lartet's essay in the 'Revue Archéologique' with that of the Esquimaux figured by Sir John Lubbock ['Pre-historic Times,' Figs. 76–78] shows that there is but little difference between the two. The barbed bone ['Quarterly Journal of Science,' Plate, Fig. 3] and the bone needle [Fig. 5] agree remarkably with those in use by the Esquimaux of Igloolik at the time Captains Parry and Lyon visited Melville Peninsula in 1821 [Figs. 4 and 6]. The marrow-spoons of both these peoples are remarkably alike, and the habit of carving various animals is common to both, and of splitting the bones for the sake of the marrow. The method also of the accumulation of the bones of the animals, and the occurrence of human remains in the refuse-heaps of the Reindeer Folk, is explained by the state of an Esquimaux camp in the Island of Igloolik. "In every direction around the huts were lying innumerable bones of walrusses and seals, together with skulls of dogs, bears, and foxes, on many of which a part of the putrid flesh still remaining sent forth the most offensive effluvia. We were not a little surprised to find also a number of human skulls lying about among the rest within a few yards of the huts, and were somewhat inclined to be out of humour with our new friends, who not only treated the matter with the utmost indifference, but on observing that we were inclined to add some of them to our collections, went eagerly about to look for them, and tumbled, perhaps, the craniums of some of their own relations into our bag without delicacy or remorse."* A carelessness of the dead similar to this would account satisfactorily for the human remains of the Reindeer Folk being found along with relics of the feast at La Madelaine and Les Eyzies. The small handles, again, of the implements found in Dordogne would prove that the Reindeer Folk were a small race. They were ignorant of pottery, and slaughtered the Reindeer and Musk-sheep for food. In fine, the cumulative evidence as to their race points towards the Esquimaux, who live under somewhat similar conditions in a very similar manner. There is nothing inherently improbable in this view that would extend the former range of the Esquimaux as far South as the Alps and Pyrenees, nor in the fact of their retreat so far North along with the Arctic Fauna. The hostility of invading tribes armed with better weapons would account for the latter, without any climatal reason being called in. In North America the dread of the Red Indian keeps a broad belt of country utterly uninhabited by them at the present day.†

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* 'Parry's Second Voyage,' p. 280. 4to.

Whether or not the Reindeer Folk kept herds of tame Reindeer, like the Lapps and Finns of Northern Scandinavia, is altogether an open question. The eminent French Palæontologist inclines to the belief that they did not, and his belief is shared by Mr. Christy, with whom he explored the refuse-heaps.

The following list of the implements and weapons of the two races of the Palæolithic age shows at a glance the immeasurable superiority of the Reindeer Folk over the Flint Folk:—

PALÆOLITHIC IMPLEMENTS AND WEAPONS.	Flint Folk of France, England, and Belgium.	Reindeer Folk of Dordogne.
Rude massive Spear-heads of Flint	*	—
Small Lance-heads	*	*
Sling-stones of Flint and Chert.	*	*
Leaf-shaped Flint Spear-heads	*	—
Flint and Chert Arrow-heads, without barbs . .	*	*
Flint Flakes	*	*
Flint Awls	*	*
Flint Scrapers	?	*
Bone Arrow-heads, without barbs	*	*
Bone Arrow-heads, with barbs	—	*
Barbed Spear-heads of Antler	—	*
Bone Needles	?	*
Bone Ornaments	—	*
Bone Spoons or Scoops	—	*
Stone Mortars (?)	—	*
Outlines of Animals on Stone, Antler, Bone, and Ivory.	—	*
Figures of Animals cut out of Antler . . .	—	

They had discarded the use of the rude massive "spear-heads" and the small leaf-shaped lance-heads of the latter; had added barbs to their hunting-arrows and spears, and had learned that bone, antler, or ivory were materials better adapted for the supplying of many of their needs than the harder and less tractable flint. The valuable work now being published in parts by M. Lartet and the representatives of the late Mr. Christy, will most largely supplement the list of the implements of the Reindeer Folk given above, and will increase our estimate of their civilization. The marvellous remains from Dordogne, in the collection of the latter, read by the light of the museum that he had spent years in forming, of implements and weapons of savages from all parts of the world, and aided by the osteological learning of M. Lartet, cannot fail to cause as complete a restoration of the habits and customs of the Reindeer Folk as that of the great secondary reptiles by Professor Owen and Dr. Mantell.

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† See 'Franklin's Journey to the Polar Sea, 1819–22, 1825–27.'

An examination of the remains of the wild animals associated with those of Palæolithic man leads to some curious results. From the following table all those animals which have not been proved to have co-existed with the Flint Folk and Reindeer Folk, though they may have been living at the time, are rigidly excluded :—

PALÆOLITHIC MAMMALS.	Bone Caves and River deposits in France, Germany, and England, associated with remains of the Flint Folk.	Caves and Rock Shelters of Dordogne.
The great Sabre-toothed Lion or Tiger . .	*	—
The Cave Lion	*	*
The Wild Cat	*	—
The Cave Hyæna	*	*
The Ermine	*	—
The Wolf	*	*
The Fox	*	*
The Badger	*	—
The Cave Bear	*	*
The Brown Bear	*	—
The Urus	*	?
The Bison	*	*
The Musk-sheep	—	*
The Common Elk	—	?
The Red Deer	*	*
The Reindeer	*	*
The Roe Deer	*	*
The Irish Elk	*	*
Antelope Säiga	—	*
Elephas Antiquus	*	—
The Mammoth	*	*
The Wild Boar	*	*
The Hippopotamus	*	—
The Woolly Rhinoceros	*	—
The Leptorhine Rhinoceros of Professor Owen .	*	—
The Horse	*	*
The Ibex	—	*
The Chamois	—	*
The Tailless Hare	*	—
The Common Hare	*	*
The Common Rabbit	*	—
The Water Rat	*	—
The Meadow Vole	*	—
The Field Vole	*	—
The Pouched Marmot	*	*
The Greater Horse-shoe Bat	*	—

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* A list of known animals in the Stone, Bronze, and Iron age will be found in the Rev. C. W. Kett's paper on "Pre-historic Records."—'Quarterly Journal of Science,' April, 1865.—EDITORS.

The extinct mammalia split up into two groups of unequal antiquity. On the one hand, we have the Sabre-toothed Lion (or Tiger), the Elephas Antiquus, the Hippopotamus, and the Woolly and Leptorhine Rhinoceros, found along with the remains of Flint Folk; and with the exception of the two last, began to live in the remote epoch called the Pliocene. On the other, the only two extinct species found in the refuse-heaps of the Reindeer Folk are the Irish Elk and the Mammoth, both of which sprang into being in the Pleistocene Period, and the former lingered on after the disappearance of the latter, and is repeatedly found in the silt of river-beds, and the lacustrine marls underlying the peat, which are of a comparatively modern date. The legitimate inference to be drawn from this is, that those deposits, containing not only the larger proportion of extinct mammals, but also an older group, are of higher antiquity than those containing a smaller proportion and a newer group; or, in other words, that the Flint Folk preceded the Reindeer Folk in time. Thus the evidence afforded by Palæontology corroborates the inference drawn from a comparison of the implements and weapons with reference to the relative age of the two Palæolithic Races.

To this view, indeed, it may be objected that the remains found in a den of Hyænas, or in an old fluviatile or lacustrine deposit, afford a better idea of the Fauna of any given district than those selected from among the wild beasts by man for food, and therefore that the absence of any particular animal from the refuse-heaps is to be accounted for by the fact of its not being met with by man, and does not prove the non-existence of the animal at the time. Had, however, any of the old Pliocene mammals co-existed with the Reindeer Folk, there is no reason why they should not have fallen victims as well as the other large mammals, the Mammoth or the great Urus. While, therefore, it is just possible that one or even the whole of the older animals *may* at a future time be discovered in association with the remains of the Reindeer Folk, the probability is that they will not be so found.

The three animals that specially characterize the Reindeer deposits of Dordogne as compared with those of the Flint Folk age, are the Antelope Säiga, the Ibex, and the Chamois; of these the former ranges now through the great central plateau of Asia, the second lives in the Pyrenees, and the last in the Alps.

Thus meagre is the outline which the scant materials allow to be drawn of the habits and condition of our earliest ancestors who lived in the Palæolithic age, — an age that coincides in part with the Pleistocene or Quaternary Period of the geologists. They passed away like many of the other mammalia, and were supplanted in Western Europe by Folk of a different race, whom Sir John Lubbock terms Neolithic. Without losing any of the useful arts of the preceding age, these invented the use of pottery, and were not ignorant of the art of spinning. They dwelt in huts, the bottoms of which are now known under the name of hut-circles, sunk in the earth, or raised on piles driven into the shallows of lakes, as in Switzerland. The tumuli spreading over France, Germany, Britain, and Scandinavia prove their belief in a future state, as well as their reverence for the dead, whom they buried without burning. They improved upon the rude unground Palæolithic implements and weapons, by adopting the custom of grinding and polishing them, and of making them out of many kinds of stone not used before, as well as by the adoption of new forms. Universally they had pressed the dog into their service, and in the Pile-works of Switzerland present us with the earliest known assemblage of *domestic* animals, the horse, pig, goat, sheep, and ox. The first of these was as rare as the last; the small short-horned variety of the existing species was abundant. They were essentially pastoral, but lived upon the fruits of the chase, the Urus and the Red-deer, as well as upon their flocks and herds. The cakes and cereals found prove that they were acquainted also with agriculture.

Sir John Lubbock infers that the tribes who have left their refuse-heaps on the Scandinavian coasts belong to an early period of the Neolithic age. Among other remains of their feasts are bones of the Great Auk (Alca impennis), which has become extinct in Europe during the present century. The oysters which composed their principal food are no longer to be found in the neighbouring seas,—a fact that would imply a physical change in the Baltic since their time, which has caused the salt water to become diluted with fresh to a greater extent now than formerly. Their habits were probably very similar to those of the savages of Tierra del Fuego at the present day.

Just as the Neolithic superseded the Palæolithic races, so was the former supplanted by the bronze-using Folk, who arrived in Europe before the dawn of history, and lived there up to the time when history begins. Their peculiar bronze swords without a guard are found throughout Western Europe, and are sometimes most tastefully ornamented. Out of this material also beautiful ornaments were made, and many of the implements and weapons which were used by the Neolithic savage. Since "Cornwall and Saxony are the only known European sources of tin," Sir John Lubbock sagaciously observes, "the mere presence of bronze is in itself a sufficient evidence not only of metallurgical skill, but also of commerce." They were acquainted with the use of the potter's-wheel, and were in the habit of *burning* their dead. For many purposes they still used stone, and doubtless the poorer made use of it for their axes, long after it had been discarded by the richer classes. The discoveries in the Swiss Lakes prove that the Bronze Folk possessed abundance of horses, and relied for their subsistence more upon their flocks and herds than upon the chase. They were more pastoral than the previous Neolithic inhabitants of the district.

The date of the introduction of iron into Western Europe cannot be satisfactorily determined. Its use had, however, spread through France, Britain, and Germany before the inhabitants of those countries came into collision with the Roman legions. The iron-using people of Gaul were sufficiently civilized and provided with weapons to be a formidable enemy to Rome in the height of her power, to oppose her disciplined troops in the field with chariots and cavalry, and on the sea to fight for a whole day with the Roman fleet off the coast of Armorica. In Britain and in Switzerland they also used chariots. The pages of Cæsar and Tacitus will give an adequate account of their civilization and habits.

In a review such as this of our Pre-historic ancestors, we must bear in mind that the absolute age of any one of the races is altogether a matter for conjecture. We can simply say that stone preceded bronze, and the latter iron, while we are ignorant of the length of time during which each of these materials was in use, as we are also of the method of its introduction, whether sudden or gradual. In this point, indeed, History differs from Archæology, that it gives the *absolute*, while the latter gives the *relative* date.

In these pages we have traced man from his earliest appearance on the earth down to the borders of history, and we have seen how, as he grew older, he profited by his experience, and slowly widened the chasm between himself and the brutes, by making his life more and more artificial. From the past it is impossible not to turn to the future and ask ourselves, whether there be any limit to the progress of the human race? Has man yet attained his full manhood? In the ages that are coming, will he not continue to win fresh victories over nature and her forces, each of which victories will form the basis for another? and as the fetters which bind him to the brutes are broken one by one, will he not grow more and more godlike, until the brutal portion of his nature be altogether swallowed up by the spiritual? Such an augury as this is warranted by a consideration of the past, by the study of History and of Archæology, and of the course of nature written in the great stone-book on which we live.

EXPLANATION OF PLATE.

Figs. 1 & 2. Arrow-head of chert, from Wookey Hole.
Fig. 3. Fishing-spear (?) of reindeer-horn, from the cave of Moustier.
„ 4. Barbed bone in use at present by the Esquimaux of Igloolik, for comparison with Fig. 3.
„ 5. Bone needle in use by the Reindeer Folk.
„ 6. Bone needle in use by the Esquimaux of Igloolik, for comparison with Fig. 5
„ 7. Sculptured figure of a horned Ruminant on a fragment of Reindeer antler from Laugerie-basse.
„ 8. Sculptured figure of the Mammoth on a fragment of ivory belonging to that animal, from the rock-shelter of La Madelaine.

IV. SCIENCE AND CRIME.

THE "MOUNTAIN ASH" MURDER.

It has frequently happened in the history of crime that some great culprit has been arraigned for poisoning, and medical or chemical evidence has been called by the prosecution as well as the defence. On such occasions it has sometimes occurred that men of the highest scientific attainments, taking opposite sides in the trial, have given evidence on apparently simple scientific questions of a totally contradictory character. Under such circumstances the counsel for the defence has not unnaturally taken the utmost advantage of the difference of opinion, and in a few isolated cases, perhaps, great criminals may have escaped the punishment which their crimes deserved. "The world," always more ready to criticize and condemn new movements, than to inquire carefully into their merits, has, in consequence of these occasional anomalies in scientific evidence, been disposed to look with contempt upon the efforts of science in the detection of crime; and "differing doctors" have become a by-word in matters of criminal law. But instead of acting as an obstruction to the course of justice, scientific investigation has become the terror of evil-doers, and if it has not succeeded in putting an end to certain classes of homicide, it is simply because criminals are either so foolish as to suppose that *their* case has been so cleverly managed as to defy detection, or so wicked as to be deterred by no considerations whatever from the execution of their designs.

We could point to innumerable cases where the administering of poison has been suspected by the medical attendant or relative, and it has been detected in the chemist's laboratory, but we feel sure it is unnecessary to adduce any evidence in proof of this to our readers; to them it must be a fact perfectly familiar in the annals of crime. Link by link the untiring chemist has formed the chain of evidence; here tracing the death-potion in the tissues, there in the stomach, there again in the heart or vascular system; and when one reads the accounts of these trials, how unerringly the guilt is almost in every case brought home to the heartless transgressor, it appears surprising that there should still remain men insensate enough to suppose they can tamper with the human system without certain detection.

Added to this facility for tracing poison, the microscopic study of the blood-corpuscles of the vertebrata has given additional means for exposing murder and violence, and recently a third method, more exquisite than any hitherto known, has been added to the list of silent, invisible detectives.

When our correspondent, Mr. H. C. Sorby, first published in these pages his astounding revelations concerning the detection of blood in fabrics,* when he told us that he could trace the presence of the vital fluid months after it had been spilt, and after the fabric had been repeatedly washed with the view to obliterate the stains, we had the pleasure on the one hand of receiving communications from scientific men who at once appreciated the great value of the discovery, and on the other hand we were amused by the sceptical shoulder-shrugs of "the world," which would be "very sorry to condemn a man to death upon such evidence."

Without here discussing the propriety of condemning a man to death on any evidence or for any crime, we have to point out the fact that "the world" is again, as it has often been and often will be, erroneous in its judgments on scientific matters; for largely if not entirely in consequence of the investigation by spectrum-analysis of the blood-stained wood of a hatchet-handle, a man at Aberdare has been sentenced to death for one of the most deliberate, cowardly, atrocious murders that the world ever witnessed.

The crime in question, known as the "Mountain Ash Murder," was committed last September by a youth, aged eighteen, called Coe, the victim being another young man called John Davies, residing in the same locality, and the trial came off in March of the present year.

It is unnecessary to pain our readers by the full details of this crime, which attracted considerable attention at the time; and we shall state as concisely as possible how scientific research succeeded in securing the conviction of the murderer. On a certain Saturday in September, the day on which he received his wages, the murdered man was last seen in company with the criminal who has since perished on the scaffold; and from that time until the 1st of January nothing was heard of him. On that day a farmer, also called John Davies (the same name as the deceased), discovered a dead body in a wood in the neighbourhood of "Mountain Ash," the head being severed from the body, and lying at some distance from the trunk. He at once applied to the police, by whom the body was removed. It was already, to a great extent, decomposed; but was identified as that of John Davies by his father; and here comes the first result of scientific acumen. The father recognized a portion of the clothing found upon the body; but this would hardly have sufficed in evidence. Young Davies had, however, had a back tooth drawn by Mr. Brown, a surgeon, *two years before the murder;* and that tooth had been preserved by the unfortunate young man's father. It was now inserted into the jaw of the corpse, and "it fitted as well as it could, considering the length of time which had elapsed."

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* "On the Application of Spectrum-Analysis to Microscopical Investigations, and especially to the Detection of Blood-stains." By H. C. Sorby, F.R.S. 'Quarterly Journal of Science,' No. 6, April, 1865.

So much for the identification of the body; now for the evidence which saddled the murderer with the crime.

The blows upon the head of the deceased which caused his death had been inflicted, the medical men said, with "some sharp cutting instrument," and it appears that on the day of the disappearance of Davies, Coe had borrowed an axe of a man called Swan, which he afterwards returned secretly and in a dirty state. This axe was carefully examined, and, as it had been cleaned by Coe on his being remonstrated with by Swan for returning it in such a state, it showed no external traces of blood; but the investigators, Dr. William B. Herapath, F.R.S. (of Bristol), and Mr. Brown, the gentleman already referred to, removed the handle and examined that portion of it which had been concealed by the blade. There they found what appeared to be stains of blood. This it was clearly proved to be by spectrum-analysis, and by ordinary microscopic observation. Dr. Herapath said, in his examination, that finding the evidence resulting from the detection of globules to be small, "I obtained more numerous sections of the coloured surface of the handle of the hatchet—immersed them in distilled water and obtained thereby a slightly coloured solution, which after filtering, was ready for chemical tests, and for optical examination by the micro-spectroscope. I subjected this fluid to the action of light, and it had undoubtedly the properties peculiar to a solution of blood. When a solution of blood was examined in this instrument (instrument here produced) the fluid absorbed some of the rays of light, and thus altered the spectrum or rainbow. Within the green and on the border of the yellow rays two dark absorption bands were produced by the blood fluid. Only one other substance* would produce two dark bands—that is cochineal dissolved in ammonia, but the position of the two bands was different. The spectroscope alone would not enable me to *readily* distinguish between the two, but combined with chemical examination it would satisfactorily do so. From this optical test I was satisfied that the sections of the hatchet had been stained with blood—and by chemical analysis I also demonstrated it was blood. The combination of the three tests showed that the substance on the hatchet must have been blood."

The globules, or blood-corpuscles we should rather say, resembled those of the human subject; or, as Mr. Brown, the surgeon, is reported to have said in cross-examination, "The globules of the blood on the hatchet were nearly the same size as those of a pig, which is the nearest in size to that of a human being."

The accused, therefore, had been last seen with the murdered man in the neighbourhood of the scene of the murder; he had borrowed and returned at the time of the disappearance of the victim just such an instrument as might have been used to inflict the injuries which caused death, and on that instrument the traces of blood had been discovered by scientific research.

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* Dr. Herapath should have said, "is at *present* known to produce."

There were many other circumstances of minor importance, which served as links in the chain of evidence, the most condemnatory of which were that Coe had made some remarks about a supposed murder at Mountain Ash, between the time when his victim disappeared and the body was found, which showed that he was aware such a murder had been committed; and that whilst Davies had been robbed by his murderer, Coe had been rather flush of money; and although the prisoner received the benefit of an anxiously-considered summing-up on the part of a most just and merciful judge, the weight of evidence was too overpowering to leave room for doubt on the minds of the jury, and he was convicted of wilful murder after an hour's deliberation. Before being executed he confessed his guilt.

Now, *we* must be permitted to "sum up." The full value of Mr. Sorby's great discovery is not exhibited by the remarkable trial to which we have here cursorily alluded. The time will come when spectrum-analysis, which has already taught us what distant suns and nebulæ are made of, will reveal to the custodians of human life that blood has been spilt upon some rag or fragment of clothing, and that discovery will serve as the *first* link in the chain of evidence that shall bring some wretched malefactor to his doom. Or, who knows but the very fact of such means of detection being in existence, may drive a stricken conscience to confess the crime, which might otherwise have remained unknown here below! Mr. Henry Sorby may, or may not, receive the reward due to him for his untiring researches; he may, at some future time, have a paltry honour pompously offered to him by some person high in office, and he *may* refuse that honour. It will be the best thing he can do, for his name will be bound up in the same volume that chronicles the works of Newton and Harvey, of Jenner, Bunsen and Kirchhoff, of Fraunhofer, and of all men of science who have, directly or indirectly, enlisted the light of the orb of day into the service of humanity; and this is a higher honour than any that princes or governments can bestow.

But let it not be supposed, because we thus sing the praises of scientific men, that we are so wanting in plain matter-of-fact knowledge as to place implicit faith in their evidence. In the first place, chemists and doctors of medicine have feelings; and, secondly, they cannot be pronounced free from prejudice. If our readers could but look over our shoulder as we scan some of the pamphlets which are sent to us from time to time, wherein the most extraordinary crotchets are chronicled, and the most grotesque hobbies ridden, often by men of science and renown, they would never suspect us of placing implicit faith in the judgment of all scientific investigators or of recommending a hasty verdict upon such evidence alone. When careful scientific research is supported by what is known as "circumstantial evidence," that is, where the circumstances under which a crime has been perpetrated are such as to render the scientific revelations credible; or, *vice versa*, where the results of scientific observation confirm the conclusions drawn from circumstantial evidence such as is usually deemed valid in courts of law, there science comes in as a witness to be respected and believed; and it will be found that every day the researches of chemists, physiologists, and microscopists are adding to the store of unquestionable facts which may be employed with increasing safety and confidence in the decision of criminal cases, and more especially in those most inhuman and detestable crimes, poisoning and assassination.

And, finally, let us on these grounds recommend barristers engaged in criminal cases, and members of the press employed in reporting such cases, to devote a little of their leisure time to the study of those branches of science without some acquaintance with which they will ere long find it impossible to pursue their respective avocations; and which will at once relieve their remarks and reports from those imperfections which raise a smile in the countenance of the scientific man, as he hears or reads the reports of cases involving the employment of technical information, or expressions in daily use in the scientific world.

V. BRITISH VOLCANIC ROCKS.—HINTS TO HOME TOURISTS.

By Archibald Geikie, F.R.S.

Summer, with its holidays, has come round upon us again, and now that the uneasy state of the Continent has well-nigh closed many of the channels through which our tide of tourists dispersed itself over Europe, the question, "Where shall we go?" becomes a somewhat momentous one to those who had proposed to themselves something more than a mere round of sight-seeing. Perhaps, if geological tastes were in the ascendant, it had been intended to ramble for a while among the traces of old glaciers on the Italian Alps, to take a few weeks amidst the extinct volcanos of the Rhine, or to peep into the geology of some pleasant upland in Central Germany. But it is hardly within the power of the lover of science to imitate Sydney's muse, who

> "Tempered her words to trampling horses' feet."

He had better in the meanwhile content himself with keeping out of the way both of trampling horses and marching men. And if he can only be persuaded that there are nooks, nay, whole leagues of ground, within his own country which will furnish him with ample recreation, both bodily and mental, he may, in the end, be brought to believe that, after all, it would not do his island countrymen a mortal injury were the Continent closed against them periodically, if they could thereby be driven to look a little more narrowly at their own land. One who has taken the trouble to make himself master of the elements of geological observation carries with him an immensely augmented source of enjoyment. Even on the ordinary tourist "routes," he can note by the way features which serve at once to heighten and to perpetuate the impressions produced by natural scenery. And when he chooses to strike away from the beaten track, and to discover for himself new wonders in scenery and new facts in science, he enjoys a succession of pleasures of which there are, perhaps, few purer or more lasting. To such an one, it may not perchance be unseasonable to suggest a field of research where the reapers have not been so numerous as in some others adjoining, and where, in consequence, there still remain a good many sheaves to be gathered—*viz.* the history of our old British volcanoes. Whether he chooses to settle down at some pleasant centre for excursions, or to make a leisurely tour through some selected parts of the country, he may still be able to carry his task with him. He will find this history legibly graven on many a hill-side in Wales, in Derbyshire, and the north of England. It is told with a strange impressiveness by hundreds of hills and valleys in the centre and south of Scotland, and throughout the chain of the Inner Hebrides; while it may be learned, too, in not a few districts of Ireland, from the cliffs of Antrim to the coasts of Waterford.

According to a vague popular belief, most of our more prominent and rugged hills owe their origin to primeval "volcanic eruptions." Thus a serrated ridge, a cluster of craggy heights, a narrow gorge, a deep half-enclosed corry or *cwm*,—these and other like features are readily seized upon by the imagination as evidence of earthquakes and volcanoes. The fanciful explanations that used to be given of them have faded away, only, however, to be replaced by others in which the fancy is hardly less rampant. The "Devil's Punch-Bowls," and "Giants' Basins" are now dimly thought of even by schoolboys as so many "craters;" and the familiar peaks and clefts in which the superstition of an older time saw the handiwork of witches and warlocks, are now popularly made to tell of vast terrestrial convulsions. So far, therefore, the spread of scientific knowledge has been able to dispel the old notions; but it has not yet advanced far enough to put the true ideas in their stead. In this, as in so many other matters, we seem to be passing through a period of transition between the exploded superstitions of our ancestors and that wide diffusion of science in the popular mind which, we are led to believe, will mark the ages of the future. In the meanwhile, such words as "volcanic," "cataclysms," "upheavals," "convulsions," and a good many more, are commonly used, and sometimes even by scientific people, in a vague, misty sense, to account for phenomena which have arrested the attention, but of which no satisfactory explanation has occurred. And so the change from the devil and the witches has not always been very much for the better; for, in truth, most of the present outlines of the surface of the country may just about as legitimately be ascribed to the agency of evil spirits as to that of volcanoes.

When we set ourselves seriously to study the matter, we soon learn, perhaps to our surprise, how small is the proportion which the number of really *volcanic* hills bears to the whole long list of hills in this country. One of the first results of such a study is to shake our faith in the truth of the common impression that present ruggedness of surface has some necessary connection with former volcanic eruptions, or that evidence of these eruptions is to be sought for only where the ground is rough and broken. But this impression is so deeply rooted, that it requires no small effort, and not a little acquaintance with facts as they are in nature, before it can be finally cast aside. But cast aside it must be, if we would make any satisfactory progress in physical geology. In no single instance in the British Islands does any hill, formed of rocks of volcanic origin, present still its original outlines. Probably its existence as a *hill* is an event long subsequent to the eruption of its component rocks, and due to a very different cause. Owing to many ups and downs, dislocations, and repeated prolonged wearing away, only a remnant of the erupted material is now to be seen. Hence all our so-called "craters" are deceptive, and take their rise from the unequal erosion of the rocks among which they lie. In like manner the conical outline so often assumed in this country by truly volcanic rocks, arises wholly from the way in which they yield to the wasting influences of nature. The most rugged parts of the British Islands are not volcanic, while some of the most remarkable traces of ancient volcanoes are to be found among corn-fields and gardens, and even under the streets of villages and towns. It is only after a careful study of the structure of the rocks that we at last discover that it is to *denudation*, or the unequal wearing away of the surface of the land, and not to movements from below, that the details of the present configuration of our country are mainly due.

The subject of the present paper is one which, I am well aware, cannot be satisfactorily discussed without ample space and an abundance of illustrations. My object, however, is not to discuss it. but rather to point out its nature, in the hope that some readers may be induced to discuss it practically for themselves in the field. Avoiding detail, therefore, as far as possible, let me endeavour to indicate, first, what volcanic rocks are, and how they are to be detected; and secondly, that we have numerous examples of them in Britain of many different geological ages.

I. All igneous rocks are not necessarily volcanic. In many cases masses of melted matter have been injected from below into the crust of the earth deep beneath the surface. It is only where the erupted material has been thrown out at the surface that it properly takes the name of *volcanic*. Hence in deciphering the geological structure and history of a country care must be taken not to misapply that term. An obvious classification of volcanic rocks is into two divisions:—1. The lava-form series, or those which have cooled down from the state of lava; and 2. The ashy series, or those ejected in the form of loose material, such as stones, cinders, dust, and ashes, which have often accumulated in thick masses both on land and under water. Each group is further subdivided according to the composition or structure of its rocks, but into these details we need not here enter further than to note that varieties of our old lavas are known as *basalt*, *greenstone*, *clinkstone*, *felstone*, or more generally as *trap;* while the ashy series includes *ash* or *trap-tuff*, *volcanic breccia*, and *agglomerate*. These rocks may evidently be studied under two very different aspects. They may be viewed either as so many mineral products coming from the depths of the earth's crust, upon the composition of which they may be expected to throw some light; or they may be looked upon as memorials of changes in the geological history of the country. Regarded in the latter light, our first object is to search for evidence that they are truly volcanic, and not merely masses which have been intruded into later rocks and cooled deep below the surface. It is evident that the occurrence of layers of ash or tuff is a sufficient demonstration that the rocks under examination were erupted either under water or in the open air, and must be of volcanic origin. For we cannot conceive of the formation of beds of such loose matter within the crust of the earth. Ash or tuff is usually an easily recognizable rock. It consists of a paste of comminuted trap with more or less intermixture of ordinary sandy or muddy sediment. Sometimes it is nothing more than such a fine paste, but it often contains an admixture of fragments of trap and other rocks varying in size from mere grains up to blocks several feet in diameter. Hence there are gradations from the finest ash, through gravelly tuff and breccia, into the coarsest agglomerate. As a rule, the coarser the material and the less mixed it is with ordinary sediment, the nearer probably does it lie to the original focus of eruption. In many ashes or ashy beds organic remains are abundant, and from these we learn that the volcanic dust was showered down upon the sea, on lakes, or on the land, and there enveloped the remains of plants and animals. When no trace of any ash is to be found, search must be made among the trap-rocks for proof that they were lava-flows, and not masses of melted matter which consolidated far beneath the surface. In the latter case they would not be volcanic, and their geological age might not be fixed, nor would they present the same variety of interest which distinguishes the truly volcanic rocks. If the trap does not occur in an amorphous mass, but is arranged in beds, there is some reason to suspect that it may have been erupted at the surface. If, moreover, the beds are found to differ in structure and texture from each other, this suspicion is considerably strengthened, and if the upper and under portions of a bed present a vesicular slaggy appearance, it may be concluded with tolerable certainty that the bed in question is an old lava-flow. When the trap occurs abundantly, it is usually not by one character, but by a number of convergent proofs that we determine it to be of volcanic origin.

Having satisfied ourselves that the rocks are relics of former volcanic phenomena, it remains to determine their geological age. When we look at a hard black *basalt*, a coarsely crystalline *dolerite*, or dull compact blue *clinkstone*, or a dark glass-like *pitchstone*, we can easily admit that they probably each belong to different eruptions. To one unacquainted, however, with the accuracy of geological research, it may seem well-nigh incredible that we should be able to arrange a true chronological series out of what seems involved from its very nature in hopeless confusion. He may find some difficulty in conceiving how it can be possible to pronounce with confidence that a certain chain of hills of volcanic rocks is older than some other chain; that one special hill in a district is younger than its neighbours; nay, that even one part of a single hill was erupted long ages after the other parts. And yet all this and more can be done very easily and with confidence. Snowdon, for instance, is built up of memorials of volcanoes immensely older than those of the Derbyshire hills; the rocks of the Sidlaw hills of Forfarshire are likewise far more ancient than those of the Lothians; the ashes and traps of Wexford belong to a time vastly anterior to those of Limerick, and the upper portions of Arthur Seat, at Edinburgh, were ejected many a long age after the volcano that gave birth to the lower portions of the hill had become extinct. The determination of these relative dates is really a matter of extreme simplicity. By the well-known geological laws of superposition and organic succession, the age of a group of stratified rocks is fixed, and if such a group contains an intercalated series of volcanic rocks, it is clear that these must belong to the same geological period. Thus in the Snowdon district the stratified rocks contain fossils which show them to be of Lower Silurian age, and hence the trappean rocks interbedded with them must be the products of

Lower Silurian volcanoes. Again, the traps of Limerick are regularly intercalated among the carboniferous limestones, and are consequently of the same age.

II. By thus attending to the geological position of the strata with which a group of volcanic rocks is associated, we learn more or less definitely the era of eruption. And as the result of such an investigation, it is known that there are in the British Islands examples of lavas and ashes of many different ages, from the Lower Silurian up even to Miocene times.

During the accumulation of the vast thickness of the Lower Silurian strata, there were active submarine volcanoes on the site of what is now North Wales; and many of the more noted hills and valleys are formed in great part out of the old lava-streams and showers of ash. Snowdon is a striking example. That mountain is built up of several thousand feet of strata of volcanic ash, mingled especially in the upper part with sandy, calcareous, and argillaceous sediment. It is in truth a colossal monument of long-continued volcanic activity. That the volcanoes of that region were submarine and not terrestrial, is shown by the occurrence of marine fossils in the ashy layers, belonging to well-known species of the Caradoc or Bala rocks. There is evidence that the volcanoes were active in more than one part of the Lower Silurian period. During the accumulation of the Llandeilo flags there was a vigorous group of submarine volcanoes in the district of Cader Idris, Aran Mowddwy, and Arenig Fawr. These died out, and afterwards, when the Bala beds were in the course of formation, the internal igneous forces broke out anew over the region around Snowdon.*

In Ireland, also, between the north of Wicklow and Waterford Harbour, the Lower Silurian series abounds in felstones and ashy beds.

The Old Red Sandstone of Scotland contains a great development of volcanic rocks. They form the chains of the Sidlaw and Ochil Hills, the Pentlands, and other groups. They are felspathic traps, ashes, and conglomerates, forming, by their decomposition, smooth green uplands and detached green conical hills.

Throughout the central valley of Scotland, also, the carboniferous formation is richly charged with traces of contemporaneous igneous rocks. Indeed, during the growth of that formation the lowlands seem to have been dotted over with little volcanic cones sending out each its showers of ash or streams of black lava. There are few geological sections more interesting than some of those in the Linlithgowshire hills, where alternations of trap, ash, shale, limestone, and other strata have been laid open. Sometimes, for instance, we find a bed of limestone made up of the stems of encrinites and brachiopod shells, and covered sharply by a layer of ash. The limestone points out a comparatively clear sea-bottom, and in the ash-bed we have proof of a shower of volcanic dust and stones, which covered the bottom, and destroyed the organisms that happened to be living there at the time. In other cases, the upper part of an ash-bed becomes calcareous, and a few straggling shells make their appearance, until the bed passes up into a limestone, showing how, after showers of volcanic detritus, the sea-floor became gradually coated, as before, by a layer of living and dead organisms. There are likewise occasional thin seams of coal, and abundant remains of plants indicative of sub-aerial growth, and over the whole comes usually a bed of amorphous or columnar basalt. These sections are easily visited, and deserve to be better known.

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* The reader who wishes to study the volcanic history of North Wales should read the works of Sir R. I. Murchison, and consult the elaborate maps of the Geological Survey, combining the results of long years of patient research by Ramsay, Jukes, Selwyn, Aveline, and other members of the Survey. The descriptive catalogue of the rock specimens in the Jermyn Street Museum will be found also very useful; but the great work on the subject will be Prof. Ramsay's forthcoming Memoir on North Wales.

In Derbyshire the carboniferous limestone has long been known to contain certain beds of contemporaneous trap called *toadstone.* In Ireland also there occur, at Limerick and elsewhere, beds of trap and ash intercalated among the limestones of the same formation.

The only Permian traps and ashes yet noticed in the British Islands are those recently described from Ayrshire and Nithsdale.*

Throughout the western region, from Lough Neagh northward by Mull and Eigg to Skye and the Sheant Isles, volcanic rocks play an important part. Much, if not most of the basalt, dolerite and ash of this tract is later than the chalk, and is at once the newest and most extensive mass of volcanic material in the British Islands. It has the great advantage, moreover, of being much better exposed to view than the igneous rocks of any other series. The waves of the Atlantic have carved it into ranges of lofty cliffs which stretch on, league after league, headland after headland, and island after island, for a distance altogether of not much under 250 miles. It forms the well-known scenery of the Giant's Causeway and the Antrim coast-line, Staffa, and the strange terraced pyramidal hills of Mull, and the chain of the inner Hebrides. Much remains to be known about this great development of volcanic rocks. In some places, as in Antrim and the Isle of Mull, fine clay with leaves of trees or layers of lignite have been found intercalated between the sheets of basalt. It seems likely that similar interstratifications must occur elsewhere, and perhaps in such localities, yet to be discovered, further evidence may transpire as to the history of these post-cretaceous volcanoes, and as to their definite geological horizon.

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* 'Geol. Mag.' for June, 1866.

In fine, there are few branches of British out-of-door geology in which the student will find more to interest him than in the story of our old volcanoes, or where, by diligent work, he will be more likely to discover new facts, and thus add to the treasures of the science. The apparent repulsiveness of the subject will soon disappear as he enters fully into his self-appointed task; and even if he should content himself with simply treading in the path that has been laid out for him by the laborious footsteps of earlier observers, he will not have spent a week or two in the pursuit without gaining new bodily vigour, and carrying away with him many pleasant memories of the rocks, quarries, and hill-sides among which he was at work.

VI. DE LA RUE AND CELESTIAL PHOTOGRAPHY.

It is about twenty-seven years since we were told of a remarkable discovery, made by a Frenchman, of a process by which external objects were made to delineate themselves on prepared metal plates, placed in a camera-obscura, with a perfection of detail and a delicacy of delineation which had never been approached by the human hand. The pictures so produced by Daguerre were seen and admired. The world of Science, once awakened to the fact, that the Sun's rays could be made to copy, on prepared tablets, the objects which they illuminated, went busily to work investigating the curious phenomena involved in the art of Photography. It must not be forgotten that Wedgwood, assisted by Davy, produced *unstable* photographic pictures in 1803.* Mr. H. Fox Talbot, soon after the announcement of Daguerre's discovery, produced his "Photogenic" drawings, speedily followed by his beautiful "calotype" pictures. Sir John Herschel investigated, with much industry and skill, the chemical changes produced upon organic and inorganic substances by solar agencies; and Mr. Robert Hunt published, in rapid succession, his discoveries of the developing power of the proto-sulphate of iron, of the influence of the chemical rays in accelerating the germination of seeds, his "chromatype," and other processes for producing photographic pictures. Beyond this, at the second meeting of the British Association at York, in 1844, this photographer showed that the chemical changes produced by the sun's rays were not due to their luminous power, but were the consequence of *dark* radiations, for which principle or power he proposed the name of ACTINISM—a term which has been generally adopted.

These researches appeared to confirm the results obtained

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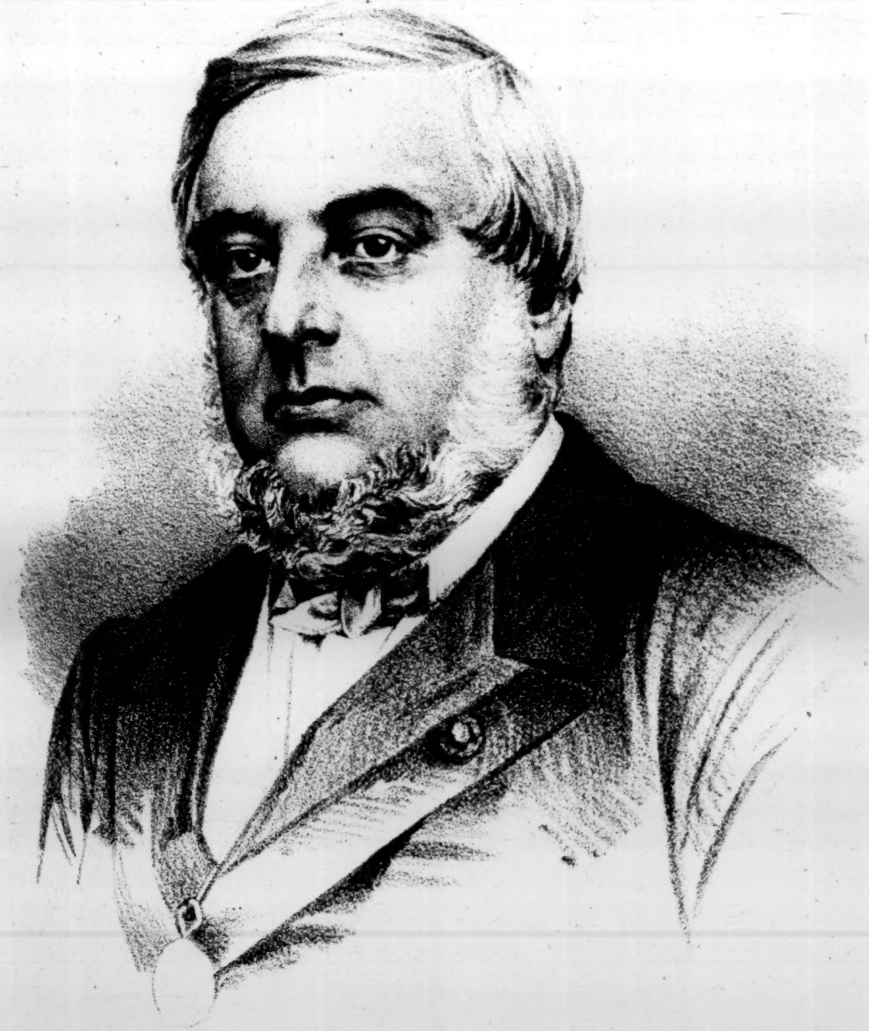
* 'Journal of the Royal Institution,' vol. i.



Vincent Brooks, lith.

Warren De La Rue

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and the hypotheses propounded by M. Berard, in 1812, which were reported upon by Berthollet, Chaptal, and Biot.*

A few years passed away: Professor Schönbein discovered gun-cotton, and at the meeting of the British Association at Southampton, in 1846, he introduced it as an important improvement upon gunpowder. As a destructive agent, gun-cotton has been slow in making its way as an agent for projecting cannon-balls or for rending rocks; but dissolved in ether, it forms that collodion which Mr. Archer, in 1851, taught us how to use in multiplying images of the beautiful, and the process to which it has given its name is now universally adopted, to the almost entire exclusion of every other kind of photographic manipulation.

At a very early period (1838–40), it was seen that the changes produced on the salts of silver by the sun's rays might be used to render meteorological and other instruments self-registering. In 1838, Mr. T. B. Jordan, then secretary of the Royal Cornwall Polytechnic Society, devised and used photographic methods for registering barometers, thermometers, and magnetometers.† These methods, modified by Mr. Brooks and Mr. Ronalds, were subsequently introduced into the observatories at Kew and at Greenwich, where, at the latter especially, under the direction of Professor Airy, a beam of artificial light now registers through each day and night every movement of those steel bars which tell us of the variations in the earth's magnetic intensity, and of the occurrence of the strange phenomena known as "Magnetic Storms," now proved, by the investigations of General Sabine, to be intimately connected with those solar spots which are being explored—if the term is admissible—by Celestial Photography. While photography was making progress as an art, it was employed in a few hands as an aid in scientific investigations. Sir John Herschel especially used chemical compounds, sensitive to solar influences, to determine the relative values of the solar radiations proceeding from different parts of the sun's disc, and this led to the determination of the fact at the same time, by two distinct observers,[*] that the chemical action produced by the rays coming from the edge of the sun were less active than those proceeding from its central regions. This fact has been, strangely enough, recently put forward as a discovery by Professor Roscoe,[†] without the mention of any previous observer, excepting Secchi, whose observations had reference to the calorific, and not to the chemical radiations. It is true that Professor Roscoe has made a series of excellent experimental observations, and that he has proved "that the intensity of the chemically active rays at the centre is from three to five times as great as that at the edge of the disc;" but in doing this he has only confirmed the results already published.[‡] For example, in 1840, Sir John Herschel, in the 'Philosophic Transactions' (Part I., p. 43), distinctly stated that he had detected "a real difference between the chemical agencies of those rays which issue from the central portion of the sun's disc, and those which, emanating from its borders, have undergone the absorptive action of a much greater depth of its atmosphere, and yet I confess myself somewhat at a loss what other cause to assign for it. It must suffice, however, to have thrown out the hint, remarking only that I have other, and, I am disposed to think, decisive evidence of the existence of an absorptive solar atmosphere extending beyond the luminous one. The breadth of the border, I should observe, is small, not exceeding 0·5, or one-seventh part of the sun's radius; and this, from the circumstance of the experiment, must necessarily err in excess."

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* "To show clearly the great disproportion which exists in this respect between the energies of different rays, M. Berard concentrated, by means of a lens, all that part of the spectrum which extends *from the green to the extreme violet*, and he concentrated, by means of another lens, all that portion which extends from the *green to the extremity of the red*. This last pencil formed a point so brilliant that the eyes were scarcely able to endure it, yet the muriate of silver remained exposed more than two hours to this brilliant point of light without undergoing any sensible alteration. On the other hand, when exposed to the other pencil, which was much less bright and less hot, it was blackened in less than six minutes."—"Report of the Commissioners:" 'Annales de Chemie.' See also, "Report on the Chemical Action of Solar Radiations:" 'Transactions of British Association for 1850,' vol. lxxxv., p. 309.

† "On a New Method of Registering the Indications of Meteorological Instruments." By T. B. Jordan. 'Sixth Report of Royal Cornwall Polytechnic Society,' 1838.

Mr. Robert Hunt, in the 'Philosophical Magazine' already quoted, noticed the same phenomenon, and gave the same, as being the most familiar explanation of it; and subsequently M. Arago, in his 'Memoirs on Photometry,' again drew attention to this important fact.

The results which have been obtained since 1840 appear to show, not merely that the chemical radiations generated near the edge of the solar disc are absorbed in passing through a greater depth of the sun's atmosphere, but that there is an actual *interference* (using this term in its ordinary acceptation rather than its scientific sense) exerted by the luminous radiations, and that the chemical radiations have their origin in a lower zone, that which produces Light-energy. The protected band which is seen to surround the prismatic image of the sun is not due to a lowering merely of chemical (actinic) intensity, as would be the case if it were an instance of loss by the absorption in the solar atmosphere; but there is evidence of a changed condition, such as is shown by the protected bands observed under the yellow and the red rays, where luminous and calorific power attain their maximum influence. On this point we have yet a few more words to say.

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[*] 'Philosophical Magazine,' vol. xvi., 3rd series, contains an abstract of the memoir read before the Royal Society by Sir John Herschel; and also a paper in the same monthly part of this magazine by Robert Hunt, on "Experiments and Observations on Light which has permeated coloured Media, and on the Chemical Action of the Solar Spectrum," in both of which this fact was, for the first time, stated.

[†] "On the Measurement of the Chemical Brightness of various Portions of the Sun's Dic." By Henry Enfield Roscoe, B.A., F.R.S. Received June 12, 1863.

[‡] See "On the Present State of our Knowledge of the Chemical Action of the Solar Radiations." A report to the British Association, in 1850, by Robert Hunt.

Professor Bond, of Cambridge, with Messrs. Whipple and Black, of Boston, in the United States, were the first to make a photographic picture of any celestial body. This was an image of the moon, obtained upon a Daguerreotype plate, which had been placed in the focus of the refracting telescope of the Harvard Observatory. In 1851, some of these Daguerreotypes of our satellite were in the American department of the Great Exhibition. In 1852, Mr. Warren De la Rue obtained positive lunar photographs, in from ten to thirty seconds, on a collodion film, by means of an equatorially-mounted reflecting telescope of thirteen-inch aperture and ten-feet focal length. At this time Mr. De la Rue had not applied any mechanical driving motion to his telescope. He was therefore constrained to contrive some other means of following the moon's apparent motion. This he accomplished by hand in the first instance, by keeping a lunar crater always on the wire of the finder, by means of the ordinary hand-gear of the telescope, but subsequently by means of a sliding frame fixed on the eye-piece holder, the motion of the slide being adjustable to suit the apparent motion of the moon. As the pictorial image of the moon could be seen through the collodion film, and could be rendered immovable in relation to the collodion plate, by causing one of the craters to remain always in apparent contact with a broad wire, placed in the focus of a compound microscope affixed to the back of a little camera-box which held the plate, this was effective.

Excellent results were obtained under the disadvantages of the want of an automatic driving motion, which proved how perfectly the hand may be made to obey the eye. Mr. Warren De la Rue was admirably aided in his earliest experiments by Mr. Thornthwaite, since it was found impossible to work without the assistance of an experienced coadjutor.

In 1853, Professor John Phillips communicated to the Hull meeting of the British Association the results of his experience in Lunar Photography, and he then exhibited some excellent pictures of our satellite. Mr. Hartnup, of Liverpool, aided by Mr. Crooke and other photographers, took some good pictures of the moon in 1854. Father Secchi, at Rome, Mr. Fry, in Mr. Howell's observatory at Brighton, and Mr. Huggins, now so well known by his application of spectrum analysis to the stars, nebulæ, and comets, also produced lunar pictures. A great extension of Celestial Photography was promised in 1857 by Professor Bond, who applied the process in measuring the distance and angle of position of double stars, and also in determining their magnitude. He succeeded in obtaining pictures of fixed stars down to the 6–7th magnitude, and everything gave promise of a fruitful future, when death put a stop to his labours.

In the same year (1857) Mr. Warren De la Rue was successful in applying a driving motion to his telescope, which answered every purpose desired; and since that time he has unremittingly followed up the subject of Celestial Photography whenever his occupations and the state of the atmosphere permitted it.

The Academy of Sciences of Paris has lately recognized Mr. De la Rue's labours, by the high distinction of the Lalande prize of Astronomy. From the address which was delivered on the occasion of its presentation, many of the following notices have been derived. As the facts thus detailed have all been subjected to the most searching examination, they stand beyond suspicion, and furnish the most reliable record which it is possible to give of the progress which has been made in an inquiry involving the use of the most perfect astronomical instruments, the most delicate physical appliances, and the most sensitive chemical preparations, directed by a zealous and thoughtful mind. It has been by means of an equatorial reflecting telescope of thirteen inches aperture, designed by himself and constructed in his own workshop, that Mr. Warren De la Rue has attained that degree of perfection in Astronomical Photography which has earned for him the gold medal of the Astronomical Society and the Royal medal of the Royal Society.

His splendid photographic delineations of our satellite, with which the scientific world is familiar, owe their excellence, first, to the perfection to which the optical part of the telescope was brought by machinery of his own contrivance; and, secondly, to the remarkable performance of his clockwork-driving apparatus, which not only works smoothly and equably, but is capable of rapid and easy adjustment to the ever-varying velocity of the moon. Mr. De la Rue's chemical training has, moreover, enabled him to secure that nice balance of affinities in his photographic preparations, which has materially reduced the time required to impress the image on the sensitive tablet, and consequently to diminish the bad effects of disturbance of the image, resulting from the unsteadiness of our atmosphere. By these means, pictures of the moon have been repeatedly taken by him in the focus of his reflecting telescope, so perfect as to bear considerable amplification—for example, to thirty-eight inches in diameter. These images admit of measurement with the microscope, so exact as to furnish excellent data for investigations in relation to a supposed physical libration of the moon. These pictures are also now being used as the foundation of the large map of the moon, six feet in diameter, which is being laid down by the Moon Committee of the British Association, as the basis of the intended zone observations of the lunar surface, by the co-operative action of certain English astronomers. The beautiful stereoscopic views of the moon, with which all are familiar, have done much, and are capable of doing more, in throwing light on the configuration of the lunar surface. It is especially the stereoscopic combinations of enlarged pictures which are calculated to impart a correct knowledge of the relative height and depressions of the terraces, undulations, dykes, and furrows of our satellite.

In pursuing his favourite subject Mr. De la Rue has successfully taken pictures of Saturn, Jupiter, and Mars, and of some of the fixed stars. The most valuable, however, of Mr. De la Rue's contributions to Astronomical Photography was the designing of the photo-heliograph of the Kew Observatory, and subsequently of the micrometer used for measuring the solar autographs, so as to bring them under the domain of calculation.

Sir John Herschel suggested that it would conduce greatly to a true knowledge of our luminary if a daily photographic record of the sun's surface were obtained. Acting upon this suggestion, and at the request of the Royal Society, Mr. De la Rue designed the Kew heliograph, which was erected at the Kew Observatory of the British Association in 1858, and has since that time been more or less worked.

In 1860, this heliograph was taken to Spain, at the desire of the Royal Society, and was successfully employed by Mr. De la Rue at Rivabellosa, in obtaining a series of pictures of the solar eclipse of July 18, before, during, and after total obscuration.

In the Bakerian lecture, read before the Royal Society on the 10th of April, 1862, the methods used in measuring these photographs are fully set forth, and the results discussed at length.*

From an early period several peculiar phenomena have been observed during eclipses of the sun, especially just before and after total obscuration. In 1733, Rydhenius, pastor of Forshem, states, "when the sun was about to lose his light, and also when he was about to recover it, *he emitted rays that undulated like the aurora borealis and were of a fiery red colour*."† Delisle has recorded an observation made in 1738 of the moon's shadow passing upon a wall at the moment of total obscuration—*tinged with different colours*,‡—by whom made we are not informed; and in 1842 some French astronomers, according to Arago,§ observed similar pheno-

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[*] 'Philosophical Transactions for 1862,' vol. clii., p. 333.

[†] 'Acta Lit. et Scien. Succ.,' tom. iv., p. 61.

[‡] 'Mémoires pour servir à l'Histoire et au Progrès de l'Astronomie.' St. Petersburg, 1738.

[§] 'Annuaire, 1846,' p. 399.

mena to those just described. In 1836, on the occasion of the annular eclipse of May 15, Mr. Baily noticed a very striking appearance, which he thus describes: "When the cusps of the sun were about 40° asunder, *a row of lucid points like a string of bright beads,* irregular in size and distance from each other, suddenly formed round that part of the circumference of the moon that was about to enter on the sun's disc." The same phenomenon occurred in a reverse order at the dissolution of the annulus. This phenomenon had been observed previously (but never so perfectly described as it was by Mr. Baily*) by Halley in 1715, by Delisle in 1724, by Professor Bayne in 1737, by the Rev. Mr. Irvine in 1748, by Mr. S. Webber in 1791,† and some others. Subsequent to Mr. Baily's observations no opportunity has been lost by astronomers; and other and yet more remarkable phenomena have claimed especial attention. By far the most striking, and we may almost say inexplicable, are the red protuberances which appear on the edge of the sun when all the direct radiations are obscured by the body of the moon.

The earliest notice which we have of those red protuberances beyond that of Rydhenius, already spoken of, is to be found in an account of the total eclipse of 1733, by Vassenius, in the 'Philosophical Transactions of the Royal Society.'‡ Vassenius speaks of them as "some reddish spots which appeared in the lunar atmosphere without the periphery of the moon's disk." These red spots appear to have attracted occasional attention; but it was not until the eclipse of 1842 that any degree of close observation was directed to them. M. Mauvais, who observed this eclipse at Perpignan, described the phenomenon as observed by him. He says, "I cannot give a more exact idea of their aspect than by comparing them to the peaks of the Alps illuminated by the setting sun, and seen afar off."§ M. Mayette, an officer of the French Engineers, compared the protuberances, as seen by him, also from Perpignan, to *beautiful sheaves of flames.* Each observer who has written on this eclipse has described the phenomenon as seen from the several points of observation along the line of totality. Mr. Baily, who was at Pavia, wrote of the luminous protuberances as having the appearance of mountains of a prodigious elevation, the colour of the peach blossom nearly representing their aspect.|| Mr. Airy was near Turin. He remarks that "in form they somewhat resembled saw-teeth in the position proper for a circular saw."¶

M. Littrow, of Vienna, and M. Otto Struve, have given carefully

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* 'Memoirs of Astronomical Society,' vol. x., p. 7.

† Consult 'History of Physical Astronomy,' by Robert Grant, F.R.A.S.

‡ 'Philosophical Transactions, 1733,' p. 135.

§ 'Annuaire, 1846,' p. 409.

|| 'Memoirs of Astronomical Society,' vol. xv., p. 6.

¶ Ibid., p. 16.

graphic accounts of these protuberances. They have also been noticed by other astronomers in all parts of the world. Sir John Herschel thus describes them: "Distinct and very conspicuous rose-coloured protuberances were seen to project beyond the dark limb of the moon, likened by some to flames, by others to mountains, but which their enormous magnitude and their faint degree of illumination clearly prove to have been cloudy masses of the most excessive tenuity."*

In 1851, Dr. Busch succeeded in obtaining a Daguerreotype of the total eclipse of that year with the Königsberg heliometer. In this daguerreotype the protuberances were seen, but indifferently defined.

In 1859, Mr. De la Rue commenced making the experiments necessary for securing a favourable photographic result, upon the occurrence of the total eclipse of 1860. The difficulties in the way of this were great. These will be gathered best from Mr. De la Rue's own words: "I made inquiries of those astronomers who had witnessed the eclipse of 1851 respecting the intensity of the light of the corona and red flames as compared with that of the moon, and the relative brightness of one to the other. . . . . The general impression I formed from the information thus derived was, that the light emitted by the corona and red flames taken together was about equal to that of a full moon, less rather than greater; but no one recollected precisely the brightness of the prominences as compared with that of the corona."† Numerous experiments were made, and it was rendered evident that the utmost sensibility must be secured in the collodion plates to leave any hope of photographing those "cloudy masses of the most excessive tenuity." The result of those preliminary experiments was that "nitrate of silver baths, prepared in the ordinary way with crystallized nitrate of silver, were taken and were used in depicting the several phases of the eclipse, with the exception of those of totality. In taking the latter pictures, the baths used were made with nitrate of silver which had been fused carefully in my own laboratory, and were so extremely sensitive that they would give photographs of the full moon in the focus of my reflector in less than a second of time, while with the usual bath five seconds were barely sufficient to give a picture of similar intensity."‡ Thirty-four cwt. of apparatus, made up in thirty packing-cases, were conveyed to Spain in the 'Himalaya,' landed at the port of Bilboa, and thence conveyed to Rivabellosa, a distance of seventy miles, by the ordinary conveyances of the country. Everything was satisfactorily arranged, and "upwards of forty photographs were taken during the eclipse, and a little before and after it, two being taken during the totality, on which are depicted the luminous prominences with a precision as to contour and position impossible of attainment by eye observations." Thus was achieved a most important end; and we have secured a record of some peculiar solar energy, or its effects, which will greatly aid us in determining the physical condition of the solar mass, and its enveloping gaseous spheres. For a full and detailed account of the apparatus used, and of the methods adopted, as well as for a graphic description of the eclipse itself, we must refer our readers to the Bakerian lecture already quoted.

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* 'Outlines of Astronomy,' edit. 1850, p. 235.

† 'Philosophical Transactions, 1862,' vol. clii., p. 334.

‡ Ibid.

In that paper the methods used in measuring the photographs are also fully set forth, and the results discussed at length. It is there shown, by measurement of the positions of the luminous prominences in the totality of pictures obtained at two epochs, one immediately after the disappearance, and the other just before the re-appearance of the sun, that the angular change of position of the luminous prominences with respect to the moon corresponds to the theory of their fixature to the sun;—That the "flames" change only apparently, not really, by the moon's motion over them—that is, as the moon covers one portion and discloses another—and do not otherwise undergo any alteration; so that when the clock, by which the telescope was moved, was adjusted to the sun's motion, the "red flames" stood still. Moreover, it is therein shown by a comparison of the photographic pictures with the optical observations made by Mr. De la Rue at the same time, that luminous prominences invisible to the human eye are depicted in the photographs; thus pointing out and exemplifying by a new experiment the difference which has been frequently shown to exist between the solar, chemical, and luminous radiations.

A curious question arises from the consideration of the chemical power evidently possessed by these prominences, be they flames or clouds. We never, as we have already stated, under ordinary circumstances obtain an impressed image of the sun without finding the indications of a protected circle—that is, one which proves a paucity of chemical power—surrounding the photographic disc. Yet, when the light of the solar disc is interrupted by the body of the moon, the radiations proceeding from the edge, or rather, perhaps, from beyond it, have a strong photographic power. What is the cause of this most remarkable difference? The question can only be answered satisfactorily by waiting for the evidence of future experiments. Those prominences become visible to the eye during an eclipse, because the eye is protected by the moon from the intense glare of solar light. They evidently belong to the sun. This was yet further proved by a careful examination of the photographs of the same eclipse obtained by Padre Secchi. The luminous prominences, due allowance being made for parallax, were identical in both, thus proving that no change takes place in the form of the prominences for a period much longer than the duration of a total eclipse. It must be borne in mind that the eclipse occurred at an interval of seven minutes between Rivabellosa, where Mr. De la Rue was stationed, and Desierto de las Palmas, where Padre Secchi was located.* Now, why is it that the photographic tablet is impressed by those attenuated images during an eclipse—and even by such of them as do not give light enough to the visible at the period of totality—and that they do not effect the required chemical change upon our sensitive plates when the sun is unobscured? The only reply which we are at present in a position to give is, that the diffused light when the sun is shining is sufficiently powerful to overcome the weaker chemical radiations of those solar clouds or flames. If this reply approaches correctness, we have additional evidence confirming the view that the two principles existing in the sun-beam, *light* or luminous power, and *actinism* or chemical power, are not modifications of the same *energy*—to use the accepted term of the day—but rather forces balanced against each other, acting indeed in antagonism. That the luminous rays have the power of entirely subduing the chemical rays has been shown by several experiments by Sir John Herschel † and others.

Referring to the 'Report on Celestial Photography in England, 1859,' we find full confirmation of these views. "Portions of the moon, equally bright optically, are by no means equally bright chemically; hence the light and shade in a photograph do not correspond in all cases with the light and shade in the optical picture. Photography thus frequently renders details visible which escape observation optically, and it therefore holds out a promise of a fertile future in selenological researches; for instance, strata of different composition evidently reflect the chemical rays to a greater or less extent, according to their nature, and may be thus distinguished. The lunar surface very near the dark limb is copied photographically with great difficulty, and it sometimes requires an exposure five or six times as long to bring out completely those portions illuminated by a very oblique ray, as others apparently not brighter but more favourably illuminated. The high ground in the southern hemisphere of the moon is more easily copied than the low ground, usually called seas, which abound in the northern hemisphere. From these circumstances, I ventured in another place ('Monthly Notices of Astronomical Society') to suggest, that the moon may have an atmosphere of great density, but of very small extent, and that the so-called seas might be covered with vegetation."*

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* "Comparison of Mr. De la Rue's and Padre Secchi's Eclipse Photographs." By Warren De la Rue, F.R.S.—'Proceedings of the Royal Society,' vol. xiii, p. 442.

† "Memoir on the Chemical Action of the Rays of the Solar Spectrum."—'Philosophical Transactions, 1840.'

In 1853, Professor John Phillips indeed noticed this difference between the visual and the actinic brightness of portions of the lunar surface.†

The application of photography to the planets by Mr. Warren De la Rue and others confirms this fact. For example, the occultation of Jupiter by the moon on November 8th, 1856, afforded an excellent opportunity for comparing the relative brightness of our satellite and that planet. On that occasion, Jupiter appeared of a pale greenish tinge, not brighter than the crater Plato, and according to Mr. De la Rue's estimate, of about one-third the general brilliancy of the moon; but the actinic power was subsequently found to be equal to fully four-sixths or five-sixths of that of the moon. "Saturn," says the same observer, "required twelve times as long as Jupiter to produce a photograph of equal intensity, on an occasion specially favourable to making the experiment; yet I obtained a picture of Saturn together with that of the moon in fifteen seconds on May the 8th of the present year (1859), just as the planet emerged from behind the moon's disc. The picture of the planet, although faint, is sufficiently distinct to bear enlarging."

Jupiter, Mars, and Saturn, together with several of the fixed stars, have been photographed; but the promise afforded by these chemical pictures is not of that high character which belongs to those of our satellite. Studying the large picture of the moon, hanging in the Royal Society's room, which has been produced by the aid of photography, we cannot but feel that we have a wonderfully minute representation of the lunar surface before us. We see, and we can measure the heights of her mountains and the depths of her valleys. Her coasts and cliffs, against which we cannot but think an ocean has at one time beaten its waters, are readily determined. We cannot mistake the craters of eruption, and we are puzzled with such as we must call craters of upheaval, vast swellings, the result of some mighty power which was yet insufficient to burst the stony bubble. Precipices so vast that darkness reigns in the profound depths over which they rise, and glens which appear indeed resigned to all the influences which superstition crowds into such weird gloom are there. Can we not trace glacial moraines? But to what are we to refer the mysterious streaks of light which flow from some of the lunar mountains? We cannot but hope, seeing how much has been done, that we shall have continuous photographic records of the moon's surface. We may then expect to have a more exact knowledge of that lovely orb which belongs especially to our Earth, and which is therefore of no common interest to the inquiring mind.

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* 'Transactions of British Association, 1859,' p. 145.

† Ibid., 1853. 'Transactions of Sections,' p. 16.

Upon the occasion of Mr. De la Rue's visit to Rome, an attempt was made, as a secondary object, by comparing the distances of the moon's and sun's centres with the tabular places, to ascertain whether any correction was necessary to the sun and moon's tabular diameters; and it was found that the latter were in excess of the observed diameters. The correction assigned to the moon's radius from two sets of the observations has been recently computed to be 2″·15, which agrees closely with the correction Mr. Airy has found to be necessary from M. Breins' reductions of forty years' observations of disappearances and reappearances of stars at the moon's dark limb during occultations.*

From 1860 to the present time, the observations by the Kew heliograph have been placed by the Council of the Royal Society under Mr. De la Rue's direction. From February, 1862, to February, 1863, the instrument was removed to the Observatory at Cranford, but a qualified assistant having been trained for the Kew Observatory during that interval, it has been worked continuously at that establishment from May, 1863, until the present time.

The object in view is, of course, to obtain the most perfect record possible of all the physical changes which take place on the sun. "The progress of science," says Mr. De la Rue,† "has hitherto only shrouded in deeper mystery than ever the origin of that wonderful outpouring of light and heat which is the sun's most prominent characteristic; and to this very day it has not been finally decided whether this luminosity proceeds from the sun's solid body, or from an envelope which surrounds it. Indeed, so strange and so unaccountable are many of the features presented to us, not only by our own sun, but by many of the stars, that it has even been conjectured that these bodies exhibit instances of the operation of forces, of the nature of which we are yet ignorant. If we accept this view of the case, the study of our luminary becomes one of very great importance, but one in which we must be very careful to be guided by observation alone. We must obtain numerous and accurate representations of the sun's surface, and study these carefully and minutely before we attempt to generalize."

In the 'Researches' from which we have quoted, we find recorded no less than 631 groups of solar spots, which have been photographed at the Kew Observatory from March 11, 1858, to December 31, 1864. The value of such a continuous record as this can only be thoroughly understood by those who have given some careful attention to this class of phenomena. This is not the place to discuss the questions which have arisen with regard to the nature of solar spots. Still it is important that a general idea should be given of the conclusions to which Mr. De la Rue and other astronomers have arrived with respect to them.

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* 'Monthly Notices of Astronomical Society,' vol. xxv., p. 264.

† 'Researches on Solar Physics.' By Warren De la Rue, F.R.S., Balfour Stewart, F.R.S., and Benjamin Loewy. (First Series, "On the Nature of Sun Spots.")

It was first stated by Dr. Alexander Wilson, of Glasgow, in 1773, that certain phenomena appeared to indicate that spots are cavities in a luminous photosphere which surrounds the sun. Mr. Dawes has shown that we have often connected with the same phenomenon—the formation of a sun spot—not less than five degrees of luminosity:—1. The faculæ, or bright streaks of irregular direction; 2. The ordinary photosphere; the *luminous* envelope of the sun; 3. The penumbra, or shaded portion of a spot.; 4. The borders of the umbra; and 5, the very dark central nucleus. The term *umbra* is used by Mr. Dawes to denote a region of a spot intermediate in darkness between the nucleus and that designated as usual by the term *penumbra*.

It should be understood that the photographs of the solar surface show with great distinctness those five degrees of illumination. Indeed, these are so decidedly delineated on the collodion tablet, that by calling in the aid of the electrotype process Mr. De la Rue has been enabled to obtain plates, from which any moderate number of copies can be printed off.

The Kew photographs have already confirmed the results of some previous observations, and established some new and important facts. We have only space to state these as concisely as possible.

1. These photographs prove the central portion of the solar disc to possess a higher degree of luminosity than the borders.

2. They have shown that the *umbra* of a spot is nearer to the sun's centre than the *penumbra*. That is, it is at a lower level. The solar spots are, therefore, cavities in the photosphere.

3. It appears fair to conclude from the examination of all the sun pictures in which the *faculæ* are copied, that "Solar faculæ consist of solid or liquid bodies of a greater or less magnitude, either slowly sinking or suspended *in æquilibrio* in a gaseous medium."

Another paragraph must, from its importance, be quoted—"The idea that faculæ are portions of the photosphere raised above the general surface, appears to be confirmed by stereoscopic pictures of spots obtained by Mr. De la Rue, where the faculæ appear as elevated ridges surrounding the spots. Accepting this conclusion, we next remark that faculæ often retain the same appearance for several days together, as if their matter were capable of remaining suspended for some time."

The deductions to be drawn from a careful study of those solar autographs are, that the lower parts of a solar spot are of a lower temperature than the photosphere in which it is formed. Whether this is due, as some suppose, to the lower temperature of the body of the sun, or to matter coming from a colder region, as is more generally thought, remains yet to be determined.

Chacornac and Lockyer have recorded observations, on the behaviour of the matter surrounding a spot, which appear to suggest the existence of a downward current, which is, therefore, a current from the colder regions above. The faculæ in the larger number of examples fall behind the spots. This appears to suggest an ascending current carrying the hot matter behind. Thus possibly two currents are concerned in the formation of a sun spot; if so, assimilating them to our terrestrial cyclones, which in many other respects they resemble.

The importance and the extension of this system of continuous observation must be evident to all; and it is satisfactory to know that a second heliograph has been made under Mr. De la Rue's direction for the Russian Government, which is now erected at Wilna, the director of that observatory, Dr. Sabler, having received instruction at Mr. De la Rue's observatory at Cranford.

On several occasions, at the Astronomical Society, Mr. Warren De la Rue has pointed out the advantages which will be derived from the use of photographic apparatus for recording future transits of Venus. In the words of the address on the presentation of the Lalande prize, we may bring our notice of Celestial Photography to a conclusion:—"By his own example, by giving instruction to others who desired it, and by continuous observations of his own, Mr. Warren De la Rue has been untiring in promoting astronomical photography; and it may be safely claimed for him that the bringing of this branch of science within the domain of calculation, marks a new era in practical astronomy."

VII. GEOLOGICAL MAPS: THEIR RELATION TO AGRICULTURE AND COAL SUPPLY.

1. *A Geological Map of England and Wales.* By G. B. Greenough, Esq., F.R.S. (on the basis of the Original Map of William Smith, 1815). New edition, revised and improved, under the superintendence of a Committee of the Geological Society of London, from the Maps of the Geological Survey of Great Britain, 1836–63, and Maps and Documents contributed by Sir R. I. Murchison, Professor Phillips, Joseph Prestwich, R. A. C. Godwin-Austen, and others. Six sheets. Scale, nearly six miles to one inch. Published by the Geological Society, July, 1865.
2. *Geological Map of England and Wales.* By Andrew C. Ramsay. Third edition. One sheet. Scale, twelve miles to one inch. London: Stanford, 1866.
3. *First Sketch of a new Geological Map of Scotland.* By Sir R. I. Murchison, Bart., K.C.B., F.R.S., and Archibald Geikie, F.R.S.E., F.G.S. One sheet. Scale, twenty-five miles to one inch. London, 1861.
4. *General Map of Ireland, to accompany the Report of the Railway Commissioners, showing the principal Physical Features and Geological Structure.* Geologically Coloured by Sir R. J. Griffith, Bart., LL.D., in 1855. Six sheets. Scale, four miles to one inch. London and Dublin.
5. *Geological Map of Ireland, to accompany the Instructions to Valuators appointed under the* 15*th and* 16*th Vic., cap.* 63. Reduced from the large map of 1855. Scale, about seventeen miles to one inch.
6. *The Geology of the Country round Stockport, Macclesfield, Congleton, and Leek. Explanatory of Quarter Sheets,* 81 *N.W. and S.W. of the Map of the Geological Survey of Great Britain.* By Edward Hull, B.A., F.G.S., and A. H. Green, M.A., F.G.S. London, 1866.

THAT geological maps are often puzzles to the public is not wonderful; but that they are sometimes a source of discussion to men of science* is much to be deprecated. If, at the outset, we endeavour to answer comprehensively the question, What is a geological map? we are met with some considerable difficulties, and we can only pretend to do so in accordance with the practice of our geological surveyors, and not with what we conceive to be the fundamental principle of the subject.

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* See 'Reader,' March 31, 1866.

A geological map of any given district ought to be as nearly as possible a faithful representation of the outlines and superficial extent of those rock-formations which occur nearest to the surface in that area—the vegetable soil being disregarded. But in practice we generally find that the geologists disregard, not only the vegetable soil, but an important series of "detrital" or "superficial" deposits which overlie and mask the more regularly stratified formations. It therefore becomes interesting to ascertain why this should be the case, and for what reason these so-called "superficial deposits" should be treated as something differing in kind from the rest of the rock-masses which form the crust of the globe.

From a scientific point of view, it is easy to draw one great distinction between the "drift" or "superficial" deposits and other formations—namely, that whereas the latter generally conform to certain general rules of dip, strike, &c., and bear a more or less definite relation to the strata above and below them, the latter are altogether irregular in their occurrence, distribution, and inclination. Doubtless exceptions may be quoted which would appear to disprove the correctness of even this wide distinction; but we are inclined to think that it is, nevertheless, correct in so far as it expresses a broad general fact. This being the case, it is certainly much easier to map the formations older than the glacial period than the glacial deposits, and the sands and gravels of more recent date. There is also no question that the distribution of the regularly stratified formations possesses a much higher scientific interest than that of gravel and other drift-deposits, which are of more or less uncertain age, and which are chiefly characterized by occurring anyhow.

From an economic point of view it is not quite so easy to pronounce in favour of one plan to the exclusion of another; but we think that the farmers of England have as great a right to the consideration of the Director-General of the Geological Survey as the miners and the geologists; in other words, it is expedient that the gravels and drifts should be mapped with the same care as the older formations, and more especially in districts which do not yield valuable minerals. A farmer who knows that some of his land has a gravelly subsoil, and the rest a clayey, wishes to ascertain the boundary-lines of the two deposits. To tell him that the clay is London clay, and is only irregularly covered by the post-glacial gravel, is to give him information that he neither requires nor understands, and to ascertain which he would never spend a sixpence. We believe that this fact has of late been recognized by the directors of the Geological Survey, and the more recently published sheets of the survey-map of Great Britain contain either delineations or indications of the outcrops of the superficial deposits.

Fortunately for the farmers, they have a powerful ally in the opacity of even superficial formations; and the reflecting geologist is no doubt often staggered at the hardihood of surveyors who draw a wriggling line of outcrop to a stratum which is known to be buried fifty, a hundred, or more feet beneath drift-deposits, and beyond the ken of mortal men.

Much may be said, no doubt, on the part of the surveyors, who, to do them justice, are really not in the habit of mapping the outcrops of strata without some tangible warrant for so doing. If a given series of beds is observed where properly exposed to "behave" in a particular manner towards those above and below them, and towards the "form of the ground," it is reasonable to infer that they will do the same at a short distance, although they may not there be seen at the surface. Thus the geological surveyor has to take note of the most trivial circumstances that may be within the reach of observation, so as to decide for future guidance what phenomena are general and what accidental. In this manner, a roadside bank speaks volumes, and a ditch reveals wonders, while a railway-cutting affords an opportunity of luxurious surveying, which ought to stimulate the surveyor to take a sanguine view of the prospects of all projected lines.

After all, the fact remains, that perhaps the greatest desideratum in British geology is a good map of the surface-deposits of the United Kingdom. We have several first-rate geological maps (in the ordinary sense) of England and Wales, and of them all, the most generally useful is no doubt Professor Ramsay's beautiful sheet, the geology of the new edition of which is much improved, while the actual and ideal sections have required no change. The new edition of the Greenough Geological Map is probably the most accurate yet published, so far as the wretched topography of most of it will allow of geological precision; indeed, it embodies the whole of the information in the possession of the Geological Survey, and the Council of the Geological Society, almost up to the date of publication; at any rate, that portion of it which was considered sufficiently authentic to be published.

The only reliable geological map of Scotland, at present in existence, is the small one by Sir R. I. Murchison and Mr. Geikie; that is to say, if the views held by the great majority of geologists, in opposition to Professor Nicol, are correct. This map leaves very little to be desired except surface-geology and a larger scale; and we hope that when a new edition is called for, the scale will be increased. Of Ireland, the old map of Sir Richard Griffith and the small reduction of it still remain the best; but we hope they will soon be superseded by a map compiled by one of the officers of the Irish Survey, for that survey must necessarily have modified our knowledge of the distribution and limits of the several geological formations in that island.

Returning to the geological maps of England and Wales, it is noticeable that if we compare the more recent with the older editions, we shall find Sir Roderick Murchison's view of the Permian age of the St. Bee's and Corby sandstones adopted both by the Council of the Geological Society and by Professor Ramsay. This is a matter of practical as well as scientific importance; for if these sandstones be of Permian instead of Triassic age, the chance of coal occurring at a reasonable depth beneath them is very much increased, more especially as the Coal-measures themselves crop out and are extensively worked at Whitehaven, immediately to the north.

The question of coal-supply, by the way, appears at last to be attracting the attention of public men; but whether any practical result will flow from this revived interest appears more than doubtful. There are many considerations respecting the supply and consumption of coal, to which Mr. Jevons did not attach sufficient weight, and which would cause us to measure England's period of commercial supremacy more favourably than that author. Nevertheless, there is sufficient cause for our striving to answer the question—By what means can we put off the day when our manufactures will cease to be able to compete with those of cotton- and iron-producing countries? That things must come to that pass sooner or later is logically certain, and American manufactures *may* be able to compete with ours much sooner than we expect.

Closely connected with this inquiry, though not a matter of such vital importance to the nation, is the probable duration of our coal-fields; and in this view it is that the determination of those new districts where coal may still be wrought at moderate depths becomes such an important element in the solution of the problem. That the latent abundance of coal will not of itself ensure our commercial supremacy is sufficiently demonstrated by the present condition of America. The consideration of most consequence is the price at which the coal can be produced, and the relative abundance or scarcity is only one out of several elements which *together* determine the price.

Facts are not wanting which tend to show that the area of our coal-fields will probably be very much increased within a few years. We have already mentioned one case of such a probable extension, and it may be worth while to give another, which is the present result of an attempt to ascertain whether workable coal-seams occur at moderate depths beneath the Lower Permian and Triassic sandstones bordering the Poynton coal-field. This attempt is described by Mr. Hull in the memoir illustrating the quarter-sheets 81 N.W. and 81 S.W. of the Geological Survey-map of Great Britain; and he states that a seam of coal three feet in thickness, and unknown in the Poynton district, was passed through by driving a horizontal tunnel from the Park pit at a depth of 200 yards from the surface; "beyond this, Coal-measure shales and clays with *Stigmaria* were proved, and the tunnel was left off in a reddish grit, similar to those found in the Coal-measures of Denton and Hyde."

It is from private enterprizes of this nature that the area of our workable coal-seams will become extended as the geological surveyors make us acquainted with the exact structure of the districts bordering our known coal-fields; but there is a more speculative kind of "prospecting" which we venture to think is a more fit, though a much more novel, subject for national expenditure than a great many others, including even expeditions to the North Pole. We refer to the probability of coal existing at no enormous depth beneath the Tertiary and Cretaceous deposits of the south-east of England, just as it is known to do beneath the chalk of Valenciennes, where it has been extensively worked; and of Calais, where it has been reached by borings. Geologists have even mapped the probable direction and extent of the subterranean prolongation of one of our great coal-fields; but opinions are divided as to the particular English coal-field with which the French (and therefore also the hypothetical London) field is connected. Mr. Godwin-Austen, who first started the notion of a London coal-field, considers it to be connected with the South Welsh and Midland coal-basins; but others hold the balance of probabilities to be in favour of the Northern coal-field. It would cost the nation comparatively little to demonstrate, by boring, the correctness or error of one or both of these views; and if coal were won, the expense might easily be defrayed, and a large source of revenue created, by a tax on the consequent yield.

VIII.—ON A TEMPORARY OUTBURST OF LIGHT IN A STAR IN CORONA BOREALIS.

By William Huggins, F.R.S.

Occasionally, but at rather long intervals, men have been startled by the extraordinary spectacle of the sudden appearance of a brilliant star in a part of the heavens where before no star was to be seen.

During the first seventeen centuries of the present era, perhaps eight or nine of these strange visitants astonished the world. It is probable that many of the objects in the Chinese catalogue of Ma-tuan-lin are not stars, but, as their observed motion appears to show, trainless comets. If we add those in this catalogue which may be supposed to be new stars, perhaps altogether about twenty of these remarkable objects have been recorded during the last two thousand years. Since 1670, no new star of sufficient splendour to attract general attention has appeared. On April 28, 1848, Mr. Hind discovered a star of between the 4th and 5th magnitude, occupying a position in Ophiuchus, where previously no star even of the 9·5 magnitude could be seen. This star has not disappeared, but remains of about the 11th magnitude.

The splendour of all these objects was temporary only. In a few days, or weeks, or months, they had waned to a great degree of faintness, and were supposed to have become extinct. Whether they really ceased to exist, or merely became invisible to the naked eye, appears to be uncertain.

For centuries the intensely interesting questions have agitated the minds of the more thoughtful of mankind. What are these strange objects? To what cause can the great but very transitory splendour of these stars be ascribed? Are they new creations, celestial ephemeræ, born to die? Are these *new stars* merely the more remarkable and extreme examples of the large class of stars which wax and wane in accordance with a special period of variation?

Tycho Brahe had the good fortune to witness the apparition of the most brilliant of these objects, the celebrated star of 1572. This star, when it first appeared, surpassed in brilliancy Sirius, Vega, and Jupiter, and could be compared alone to Venus when nearest to the earth; within seventeen months the star had become invisible to the naked eye. Telescopes had not yet been invented.

The star of 1604, at its first appearance, surpassed the stars of the first magnitude, and also Mars, Jupiter, and Saturn; but Kepler considered that it was not equal in brilliancy to Venus. This star became invisible after about fifteen months.

Tycho Brahe believed that the star of 1572 had been formed by the agglomeration and condensation of a portion of the nebulous matter diffused through the universe. The Aristotelic philosophy, which then swayed men's minds, prevented the reception of a theory which was not in accordance with the absolute perfection of the heavens. The phenomena of the sudden splendour and rapid waning of these stars were sought to be explained on the supposition that no real change occurs in the star, but that it suddenly advances towards the earth with extreme rapidity, and then retraces its steps until it vanishes in the remotely distant region from which it had emerged. No words are needed, now that the velocity of light is known, to show that this hypothesis must be rejected.

Riccioli, in 1651, extended the Chaldean hypothesis of the moon to the temporary stars, and suggested that these objects may be luminous on one side only. The variation in their brilliancy might, he supposed, be produced by a rotation about an axis. The intermittent light of some of our modern lighthouses may be mentioned as an illustration of this theory. Riccioli added, "When the Deity wishes to exhibit to mankind any extraordinary sign, he makes one of these stars turn rapidly upon its axis."

In modern days the opinion seems to have been growing that the *new* stars of history may be the periodic maxima of permanent but extremely variable stars. M. H. Goldschmidt has brought together reasons to show that the *new* stars of A.D. 393, 827, 1203, and 1609 were probably periodic outbursts of light in one and the same star.

In a recent work of considerable interest,* Dr. J. C. Zöllner endeavours to explain the phenomena of the heavens in accordance with the hypothesis of a nebulous origin of the universe. He supposes that a fiery mass in the process of cooling would become surrounded with a crust of cooled matter. He conceives further that the sudden bursting of this external crust and the outflow of glowing matter from within might present appearances not unlike those furnished by the temporary stars.

Thanks to the researches of Kirchhoff and others we now possess a method of analyzing the nature of a distant source of light, which, it might be expected, would give to us some information of the true condition of the enormous changes which must be taking place in these stars of ephemeral lustre. The observations of the writer and his distinguished colleague, Dr. W. A. Miller, have shown that matter of a nature common to that of our system, and subject to physical laws similar to those which prevail on the earth, exists throughout the stellar host. It was therefore to be expected that the phenomena of the temporary stars were due to physical changes, of which the precise nature might be revealed by prismatic examination.

It has been the good fortune of the writer, conjointly with Dr. W. A. Miller, to examine the spectrum of a bright star, which during the past month suddenly burst forth in the constellation of the Northern Crown.

The sudden outburst of light in this star appears to have been first seen by Mr. John Birmingham, of Tuam, on the 12th of May. In a letter to the writer, Mr. Birmingham describes the star as appearing on that evening "very brilliant, of about the 2nd magnitude, certainly more brilliant than α Coronæ."

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* 'Photometrische Untersuchungen mit besonderer Rücksicht auf die Physische Beschaffenheit der Himmelskörper.' Leipsig, 1865.

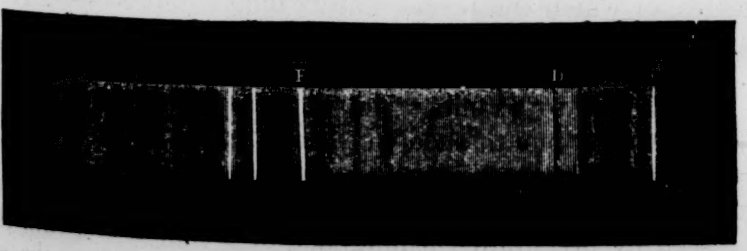
The next evening, the 13th, the star was seen by M. Courbebaisse, at Rochefort, France. On the 11th, this observer had not noticed any new star in the Crown. On the 14th it was observed in Canada by Mr. W. Barker. It was then of the 3rd magnitude. The star was again independently discovered by Mr. Baxendell, on the 15th, at Manchester.

On the 16th, the writer received a letter from Mr. Baxendell, in which he describes the star as "about somewhat less than a degree distant from ε Coronæ, in a south-easterly direction, and last night was fully equal in brilliancy to β Serpentis, or γ Herculis, both stars of about the 3rd magnitude."

On the same evening, the 16th, the writer and Dr. W. A. Miller commenced a prismatic examination of its light.

The star was then below the third magnitude, but brighter than ε Coronæ. In the telescope it was surrounded with a faint nebulous haze, extending to a considerable distance, and gradually fading away at the boundary. A comparative examination of neighbouring stars showed that this nebulosity really existed about the star. On the 17th, this nebulosity was suspected only; on the 19th and 21st, it was not seen.

When the spectroscope was placed on the telescope, the light of this new star formed a spectrum unlike that of any celestial body hitherto examined by them. The light of the star is compound, and has emanated from two different sources. Each light forms its own spectrum. In the instrument these spectra appear superposed. The principal spectrum is analogous to that of the sun, and is evidently formed by the light of an incandescent solid or liquid photosphere, which has suffered absorption by the vapours of an envelope cooler than itself. The second spectrum consists of a few bright lines, which indicate that the light represented by it was emitted by matter in the state of luminous gas. These spectra are represented with considerable approximative accuracy in the following diagram.



Spectrum of absorption, and spectrum of bright lines forming the compound spectrum of a new star near to ϵ Coronæ Borealis.

From this diagram the reader will notice at the red end of the spectrum a little more refrangible than Fraunhofer's C, two strong dark lines; between these and a line a little less refrangible than D, are a number of fine lines very near each other. About the place of solar D is a less strongly-marked line, and between that and the position of *b* in the solar spectrum there are numerous faint thin lines of absorption. Beyond *b*, as far as the spectrum can be traced, are close groups of strong lines. This is the spectrum of the light of the photosphere interrupted by the special absorption of the cooler vapours which surround it.

The spectrum of the light from a *gaseous* source consists of fine bright lines. These appear in the instrument, as they are represented in the diagram, as if superposed upon the spectrum already described. The brightest of these lines was found by micrometric measures to coincide with Fraunhofer's F. On the 17th, this line was found by a simultaneous observation of it, with the lines of hydrogen, to agree exactly in position with the middle of the expanded line of hydrogen in the green. Another bright line occurs in the red, and appears to coincide with solar C and the red line of hydrogen.

There are two bright lines more refrangible than F, and a fifth line was seen by glimpses near G of the solar spectrum. This may possibly coincide with the blue line of hydrogen.

The compound spectrum of the rapidly waning star was observed on several evenings up to May 28th. No important changes were noticed. From the 16th to the 20th the spectrum from the photosphere appeared to fade more rapidly than the bright lines from the gaseous source.

The position of the groups of dark lines shows that the light of the photosphere, after passing through the absorbent atmosphere, is yellow. The light, however, of the green and blue bright lines makes up to some extent for the green and blue rays (of other refrangibilities) which have been stopped by absorption. To the eye, therefore, the star appears nearly white. However, as the star flickers, there may be noticed an occasional preponderance of yellow or blue. Mr. Baxendell, without knowing the results of prismatic analysis, describes the impression he received to be "as if the yellow of the star were seen through an overlying film of a blue tint."

These observations, with the prism, enable us to form the following conclusions respecting the constitution of this remarkable star. There must be a photosphere of matter in the solid or liquid state emitting light of all refrangibilities. Surrounding this must exist also an atmosphere of cooler vapours, which give rise by absorption to the groups of dark lines.

Besides this constitution, which it possesses in common with the sun and the stars, there must exist the source of the gaseous spectrum. That this is not produced by the faint nebulosity seen about the star is evident by the brightness of the lines, and the circumstance that they do not extend in the instrument beyond the boundaries of the continuous spectrum. The gaseous mass, from which this light emanates, must be at a much higher temperature than the photosphere of the star, otherwise it would appear impossible to explain the great brilliancy of the lines compared with the corresponding parts of the continuous spectrum of the photosphere. The position of two of the bright lines suggests that this gas may consist chiefly of hydrogen.

If, however, hydrogen be really the source of some of the bright lines, the conditions under which the gas emits the light must be different from those to which it has been submitted in terrestrial observations; for it is well known that the line of hydrogen in the green is fainter and more expanded than the brilliant red line which characterizes the spectrum of this gas. On the other hand, the strong absorption indicated by the line F of the solar spectrum, and the still stronger corresponding lines in some stars, would indicate that under suitable conditions hydrogen may emit a strong luminous radiation of this refrangibility.

When the information received from spectrum analysis is considered in connection with the sudden outburst of light in the star, and its rapid decline in brightness from between the second and third magnitude down to the eighth magnitude in about twelve days, the bold speculation presents itself that the star has become suddenly enveloped in flames. In consequence of some great convulsion, on the precise nature of which it would be idle to speculate, enormous quantities of gas have been set free. A principal part of this gas consists of hydrogen, and this is burning about the star by combination with some other element. This flaming gas emits the light represented by the spectrum of bright lines. The spectrum of the other part of the star's light shows that this fierce gaseous conflagration has heated to vivid incandescence the solid matter of the photosphere. The writer regrets much that he had not the opportunity of examining the spectrum of the light of this star at an earlier period. It would be of importance to know whether, at the first outburst, the bright lines of the gas only would have been seen. Some little time would appear to be necessary for the photosphere to acquire the temperature necessary for incandescence.

As the free hydrogen becomes exhausted, the flames abate, the incandescence of the photosphere becomes less vivid, and the star rapidly wanes.

We must not forget that light, though a messenger swift of wing, requires time to traverse celestial space. The great physical convulsion, of which we have been the spectators, is already a matter of history in the case of the star itself. The star has been for years (for ages?) in the enjoyment of the new conditions which this fiery catastrophe has originated.

An important question remains, Is the star really *new?* The Astronomer Royal informs the writer that meridian observations of this star at Greenwich show that its position agrees precisely with a star observed by Argelander of the 9·5 magnitude. Sir John Herschel has informed the writer, that on June 9th, 1842, he saw a star of the 6th magnitude in a position in Corona nearly the same as that of this new star. As the place of the star was laid down merely by naked eye allineations, the object seen by Sir John Herschel may possibly have been the same star during a former similar outburst of light.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The gradual decline of the cattle plague during the past quarter has amply justified those measures of repression and restriction which had been enacted at the date of our last publication, and to which we then alluded. The latest report of the Commissioners appointed to investigate the subject points out that, up to the date of the Act which authorized the compulsory slaughter of infected cattle, the fatality of the disease was constantly increasing; but that, after that date, it at once commenced a continual decline which has since been almost regularly maintained. This diminution has not only been coincident with the action of the new restrictive measures, but runs a course closely parallel to the operation of the most important of those measures—compulsory slaughter. "Rigid and systematic means of disinfection," "unsparing strictness and unremitting watchfulness," will alone, in the opinion of the Commissioners, be sufficient to extirpate the disease, and when these measures have been successful, there will still remain the duty of guarding against its re-introduction. A few cases have been reported in the north of Ireland; but the rigid isolation of the infected spot appears hitherto to have prevented its extension there. The liability to its re-importation is, however, strikingly illustrated by the Irish experience, and this will, we fear, necessitate a constant and increasingly careful inspection at all those points of debarkation at which we now receive our supplies of foreign cattle. This, combined with either quarantine or immediate slaughter, will be necessary; for the complete investigation of the subject, which a quarter of a million of cases has forced upon us, only deepens the conviction that no remedy exists for the malady when once the poison has been received. The Commissioners inform us that all forms of medicinal treatment have been equally successful, and all have been equally unsuccessful. The regulation of diet has, however, been serviceable—"judicious feeding with soft mashes of digestible food has tended to increase the proportion of recoveries. And it is a noteworthy circumstance, that the proportion of recoveries is larger in the case of small herds than in that of large flocks, thus pointing out how much may be done by careful nursing and individual attention." "Among cottagers' cattle, generally fed on mashed food, the recoveries were 73 per cent.; in large stocks, where dry food has been given during convalescence, the recoveries were 57 per cent.; with mixed food of mashes and hay, they were 22 per cent.; while, among cattle fed entirely with dry food, and treated medicinally with drugs, the recoveries were but 13 per cent." These results were gathered out of the history of 503 cases, of which 191, or nearly 38 per cent. on the whole, recovered. We add that the returns published on June 1st intimate that 244,455 cases, in all, had occurred up till that date, of which 1,207 were reported during the previous week; the weekly numbers having been sinking very rapidly indeed since the month of March, when the number of attacks amounted in one week to as many as 18,000.

The number of animals hitherto reported as having died or been slaughtered does not much exceed 200,000 of all ages, or barely 5 per cent. of the number which recently published statistics declare to be the present cattle population of Great Britain; but the losses have no doubt been greater on the whole than the Government returns declare; and there is this especial aggravation of their severity, that they have not been evenly spread over the country, but have fallen with destructive effect on particular counties. In Cheshire, for example, which is almost exclusively a dairy county, no fewer than 4,800 places have been visited by the plague. In these places there were 90,434 cattle, of which 60,574 have been attacked, and upwards of 50,000 of them are dead. The quiet arithmetical view of the subject as a national loss, which a mere statist may be disposed to take, thus altogether ignores the almost absolute ruin which has befallen individual localities and even counties. Our immunity for the future depends a good deal upon the efficiency of the disinfectants which have been employed in those localities where the disease has occurred, and where, if the poison which is left by it has not been thoroughly destroyed, it will be almost certain to occur again. It appears to us that some risk arises here out of the insufficient distinction made in the popular estimate of them between true disinfectants and mere deodorizing antiseptics. The latter do, in effect, merely lock up the poison which they deal with; and the harmless condition to which, for the time, it is reduced by their agency, may be only a temporary result of their employment. Lapse of time may set it free again; and, plainly, it is only those agencies which decompose and break up the organic matters implicated, redistributing their elements in new forms of combination, that are unquestionably and ultimately trustworthy. For these reasons, we should greatly prefer, after a thorough washing of the infected premises with some alkaline ley, the use of sulphurous acid or chlorine gas—the one obtained by burning sulphur and the other by adding hydrochloric acid to the peroxide of manganese—in the cow-house where the plague has been, to the use of carbolic and other tar acids. And we believe that the agricultural public are greatly indebted to Dr. Voelcker, the chemist of the Royal Agricultural Society of England, and to Mr. Walter Crum, F.R.S., for that distinction urged by them between disinfectants and antiseptics, which does not appear to have received due attention in the recommendations of the Cattle Plague Commissioners.

Reference was made last quarter to the then impending attempt to collect statistics of our live stock. The returns have since been published, and we learn that on the 5th of March (when, however, neither the calving nor the lambing season was over) we had the following quantity of live stock in the country:—

	ENUMERATED, 1866.		
	Cattle.	Sheep.	Pigs.
England	3,307,034	15,124,541	2,066,299
Wales	541,401	1,668,663	191,604
Islands	17,700	57,685	22,887
Scotland	937,411	5,255,077	219,716
Ireland	3,493,414	3,688,742	1,299,893
Total	8,316,960	25,794,708	3,800,399

This amounts, as regards Great Britain, to about 10 cattle of all ages, 40 sheep, and 6 pigs, to every 100 acres of England; and to 5 cattle, 28 sheep, and 1 pig, to every hundred acres of Scotland, of which, of course, so much larger a proportion is waste and moorland. Another table in the Government returns on this subject indicates the corresponding live-stock population of other countries. Comparing it, however, not with the acreage, but with the human population of the several countries, the extent of their dairy husbandry is very strikingly illustrated by this table, which shows, that while there is only one cow for every nine persons in Great Britain and Ireland, there is one for every two in Denmark, one for every three in Holstein, one for every three-and-a-half in Sweden, Holland, Prussia and Saxony; one for every six in Austria, and one for every six-and-a-half in France. The universality of the cattle plague in Cheshire is shown in these returns by the number of cattle in that county, 93,844, as compared with 90,439, which is the number on those farms where the disease had appeared.

The meat supply of the country has received ample discussion during the past quarter at the hands of both local and central societies. The increase of fertility by both deeper tillage and more liberal manuring, the adoption of special rotations of crop, and, in particular, the cultivation of green crops in succession to one another; the use of potatoes, and of home-grown grain, as cattle food; the selection of fitting breeds and animals and their management during the growing and the feeding periods, which are now understood to be coincident from beginning to the end of each, was fully discussed by Mr. Robert Smith before the London Farmers' Club, and by Messrs. Hope, Wilson, and McCombie, before the Edinburgh Chamber of Agriculture. The special details of cultivation and field management necessary to a large production of food for live stock on the farm have been carefully described by Professor Wrightson, of the Royal Agricultural College, before the Cirencester Farmers' Club, and by Mr. Alderman Mechi, before the Wenlock Farmers' Club: and capital papers on the general management of live stock, and on that particular treatment of this department of farm management which the cattle plague has called forth, have been delivered before English, Scottish, and Irish Farmers' Clubs. The society which has probably done least for any serviceable mitigation of the calamity which has befallen us is the Royal Agricultural Society of England, whose council were, at the late general meeting of the society, taken vigorously to task by Mr. Arkell, a Wiltshire farmer, for the inaction they had displayed.

We must except from the charge of that usually deficient and imperfect discussion of agricultural subjects which they receive at the occasional meetings of the English Agricultural Society, one very instructive lecture recently delivered in its rooms by Dr. Voelcker, on the proper conditions of field-experiments. The following were the points to which he referred:—

1. Such experiments need not be on a large scale. One-twentieth part of an acre of root crop, one quarter of an acre of corn or grass, will answer fairly any simple question that is put to it by the application of a manure. A larger extent sometimes involves a fatal difference of treatment in the several parts of it, and unless the plots be small enough to be treated virtually *together*, the results will not be capable of comparison.

2. These experiments ought to be conducted on soil of what may be called an *indifferent* character—level, fairly drained, uniform as to depth, and without any marked character as to composition or texture. It should be neither stiff nor light; nor should it be too rich, for as the distinctive effect of different foods cannot appear in the case of a man already fully fed, so manures cannot produce their characteristic effect, or indeed any effect at all, on soil already full of all that plants require.

3. The result of the experiment depends on the time and mode in which it is conducted. As to time:—Experimental manurings on grass lands on which it is proposed to try the effect of slowly dissolving fertilizers should be done in autumn. Even ammoniacal salts may be applied in autumn, if on land possessing any retentive character. Nitrates, on the other hand, which the soil allows to

pass through it, must not be applied till spring. It is thus plain that a comparison of ammonia salts with nitrates sown together in autumn will give very different results from a similar comparison made in spring time. As to mode:—Care must be taken to ensure the uniform distribution of the fertilizers. Concentrated manures should be mixed with at least three times their bulk of some harmless diluent. The broadcast manure distributor should be employed to ensure their uniform application to grass or corn, or they may be sown by hand over the drilled fields for roots before the plough covers the dung in the drills by splitting the intervening ridgelets.

4. A careful record must be kept of the composition of the manures employed, of the character of the soil, and of its past agricultural history, in order that the result may be read in the light of the information thus preserved.

5. It is of the greatest importance that the experiment be devised so as to reply to a very simple question. If complicated mixtures of manures be used, the result cannot be attributed to its proper cause with any certainty. Let the experiment be devised so as to be sure that it shall answer "yes" or "no," as to the effect of a single ingredient.

6. The experiments, moreover, must have regard to the fitness of the soil and climate to the plant which is employed to test the manures by. It is as useless to try the effect of manures on Indian corn in Scotland as it would be to test them by means of mangel wurzel in Sweden. So also the soil should be fitted to the habits of the plant. The lupine fails on land with a hard, cold subsoil, not because the food it requires is not present, but because its deep taproot requires a subsoil in which it can extend.

7. In reading the results of experiments, regard must be had to the character of the season, wet or dry, early or late, cold or warm. And extreme diligence should be used in noting all the successive appearances of the crop under variations of weather throughout the year.

Lastly, the operator must not only have unbounded patience—waiting long and putting his question frequently before he satisfies himself that he has got the answer—but he must have both pluck and self-denial enough to throw his results into the waste-paper basket, rather than mislead his brother farmers by the publication of unsatisfactory conclusions.

On this same subject Professor Buckman has pointed out that careful observation by the farmer of the varying natural conditions under which the ordinary rules of farm practice are carried out, will often teach as much as can be learned from well-defined experiment, provided a careful record be kept of the field-results which are obtained under the varying circumstances of early or late farming, cold or warm, wet or dry air and soil, and even deep or shallow tillage and seed bed, all of which may have been imposed upon him by the character of the year.

The list of recently introduced agricultural plants, on which Mr. Buckman comments in the columns of the 'Agricultural Gazette,' includes the following:—Schroeder's Brome grass, a coarse species of a coarse genus, which is not likely, except under sewage irrigation and excessive consequent succulence of growth, to be of much service to English agriculture: *Anthyllis vulneraria*, or Lady's fingers, a common English wild plant, whose hairiness and dryness are said to be diminished or to disappear under cultivation, so that in certain circumstances it becomes a useful forage plant: *Symphytum asperrimum*, the prickly comfrey, yielding a large bulk of forage useful as cow-food, which, however, requires to be cut often while young, as it soon becomes too rough and unmanageable: and the cattle gourds or melons, which furnish in hot summers a great quantity of somewhat insipid and watery flesh, also good for cow-food.

Among other subjects less within the scope of this "Chronicle," to which the attention of agriculturists has been directed during the past quarter, are the need of central chambers of Agriculture, through which attention to class interests can be urged upon Government; the necessity of altered arrangements for the supply of animal food to consumers—an extension of the dead-meat market at the expense of the existing live-cattle markets, in London and in other large inland towns; and the existence of considerable dissatisfaction in many country districts with the rate of payment for farm-labour. No doubt this will gradually rise, and it is very desirable that it should. The rapid draught which is being made upon the number of the labouring class in rural districts by other better-paid occupations tends inevitably to this result. And the greater need of labouring men which exists in agriculture, with every extension of the meat manufacture now stimulated so much by market prices, acts in the same direction.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

Mr. W. L. Dickinson has read a paper before the Literary and Philosophical Society of Manchester, containing the results of calculations relative to the Eclipse of the Sun, and to two Occultations of the star Aldebaran by the Moon, visible this year. The calculations have been made for the Observatory of Robert Worthington, Esq., F.R.A.S., Crumpsall, near Manchester, Lat. 53° 30′ 50″·0 N., Long. 0° 8′ 56″·16 W. The elements used in the computations have been obtained from the 'Nautical Almanack.' The partial eclipse of the sun, October 8, 1866, is partly visible at the Observatory, and

Begins . . . . 4h. 19m. 39s. } Mean time at Greenwich.
Greater phase . . 5h. 21m. 35s. }

At Crumpsall the Sun will set at 5h. 27m. Magnitude of the eclipse (Sun's diameter = 1). 0·480.

Angle, from North Pole, of first contact, 43° . } Towards the west for direct image.
Angle, from Vertex, of first contact, 76° . }

At the same meeting of this Society, Mr. Brothers, F.R.A.S., stated that, while observing the Moon with his five-inch achromatic telescope, at about eight o'clock on the evening of March 25, he observed a small dark body cross the disc diagonally, from left to right, a little below the spot Copernicus. The motion was very rapid, and similar to the passage of a luminous meteor across the field of view. He conceived it might be a meteoric body passing through space at a distance considerably beyond the limits of the earth's atmosphere.

Mr. Daubrée has given to the Academy of Sciences a continuation of his "Synthetical Researches relative to Meteorites." In this part he shows that the siliceous constituents of meteorites are, for the most part, basic silicates, differing from the silicates constituting the superficial crust of the earth, but closely resembling the eruptive rocks. He supposes the masses to have been formed originally at a very high temperature, but for several reasons believes that they have crystallized at a lower temperature than in his own experiments to reproduce them. He supposes also that the fragments which reach our earth have been detached from much larger masses, probably at a far distant period of time. But although long circulating in space, it is only when they reach our atmosphere that they suddenly become incandescent, by which their exterior becomes vitrified, while the interior remains unchanged. The interior, therefore, represents the state of the mass as it circulated in space. It is clear, however, that oxygen has played an important part in the formation of meteoric stones, and the author also thinks in the formation of all planetary bodies. This part of M. Daubrée's paper is very long, and we have only indicated the principal point. The memoir is a valuable contribution to chemical geology.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

By desire of the Rev. R. Main, Director of the Radcliffe Observatory, Oxford, Prof. F. Kaiser, Director of the Observatory at Leyden, has presented to the Royal Astronomical Society a brief account of his investigations of Airy's double-image micrometer. The Astronomer Royal himself has given a complete theory and description of this micrometer. From that theory and description it appears that, with the double-image micrometer, errors are to be feared arising from the following sources:—(1), Periodical errors of the micrometer screw; (2), Variability in the mutual distance of the threads of that screw; (3), Distortion of the images.

The periodical errors of the screw may be very different at small differences in the readings of the micrometer-head, and require therefore a particular inquiry. The errors arising from the sources (2) and (3) do not compensate themselves in brief periods, and their common amount may be determined by the same inquiry.

In the micrometer as made by Simms one half-lens is quite fixed, while only the other can be moved by the micrometer-screw. This construction makes it impossible to eliminate the periodical errors of the screw at the measurements themselves. If the fixed half-lens could only be moved so much as the amount of one revolution of the micrometer-screw, we could hereby (according to Bessel's theory) eliminate at each measurement the periodical errors of the screw, and this would be a great gain. If the fixed half-lens could be moved as much as the movable one, the measurements could be extended to angles twice as large as can now be measured with the micrometer. Then it would, however, be shown together, with relation to the fixed lenses. By this modification the price of the instrument would certainly be considerably raised, but it would be well worth the extra expense.

After a long and elaborate investigation of the various errors and methods of eliminating their influence on the final results, Prof. Kaiser arrives at the conclusion that the Astronomer Royal has, by the invention of his double-image micrometer, rendered an important service to astronomy. Indeed, he doubts whether, besides the heliometer, a second double-image micrometer exists by which measurements can be effected so accurately as by Airy's instrument. That instrument requires, however, a very rigorous and difficult inquiry, in order to give it the accuracy of which it is capable, and it demands also great prudence in the use of it.

A micrometer like Airy's can only render its services if it is adapted to a large and precious refractor. The price of the micrometer would, even if it were doubled, still remain very insignificant in comparison with that of the refractor. Therefore it would appear very desirable to give to the micrometer the more complicated construction above alluded to, even if its price were thereby considerably increased.

Rev. T. W. Webb has given a further notice of the great nebula in Orion. A comparison of the various representations of the great nebula in Orion, which have been given for a period of many years, seems to lead inevitably to the conclusion that our knowledge of its real aspect is still far from complete. While Mr. Huggins's most important discovery of its true constitution renders the idea of change more conceivable, it must be admitted that any alterations of form or brightness which may have been in progress since the employment of the telescope are so masked by discrepancies of declination as to preclude the possibility of drawing any fully satisfactory conclusion.

It would be superfluous to refer to the variations which are so well known to arise from diversity of weather, instruments, eyes, and pencils, and especially from the unwarrantable carelessness of engravers: it only remains to be considered whether these are the sole causes of the striking differences by which we are confronted, or whether, after making due allowance for all these sources of error, there may yet be a residuum of actual change. No other means of investigating this point seem so promising as the multiplication of designs by different observers, in different climates, and with different optical means. From such an accumulation of testimony we might hope to deduce a much closer approximation to the truth.

The sketch, of which a copy was shown to the meeting, was commenced in December, 1863, and continued with many interruptions till the present season.

In this attempt to show some part of what may be visible in a certain circumscribed portion of the nebulosity, with an achromatic of 5½ inches aperture and an eye of average capacity, the object has been to represent the general arrangement of the luminous haze; and the few stars contained in the sketch are inserted merely for the purpose of more convenient identification and reference.

The author stated that he had the less hesitation in bringing forward these particulars, as he had the pleasure of knowing that his observations on the "rift" and the "lake" or opening, had been in great measure confirmed by Mr. Knott with his beautiful 7⅓-inch object-glass; and it was therefore believed there would be little difficulty on the part of any adequately provided observer in verifying them.

A. S. Herschel, Esq., has given an interesting account of the Path of a Detonating Meteor. Shooting-stars, it is well known, are so abundantly observed on certain nights of the year, that already, at the end of the last century, the term *meteorode* was applied on this account to the night of the 10th of August. It is suspected that large meteors also make their appearance on fixed nights of the year, although not with the same frequency or regularity as the most constant star-showers.

On the 21st of November, 1865, at 6h. 5m., G. M. T., a meteor about three times as bright as Venus is at its brightest, and having an apparent diameter of 8′ or 10′, was observed by Mr. Warren De la Rue, near Cranford. The meteor rose from the eastern horizon, being surrounded at first, like a comet, by a parabola-shaped halo of light, reminding an observer of the zodiacal light in its form, but rapidly rising and becoming brighter. When at an altitude of about 40° due east, the meteor emerged like a fireball from a roman candle, of a blue colour, about a quarter of the apparent diameter of the full Moon in width, and drawing after it a trail of reddish-coloured sparks, $2\frac{1}{2}$° or 3° in length; as it passed overhead the out-pouring and falling behind of the matter forming the train became distinctly visible. At Wimbledon, near London, where the meteor was seen by Mr. F. C. Penrose, it vanished suddenly, or at any rate very rapidly, about 8° N.W. of *a Lyræ*. It traversed the entire length of the valley of the Thames—a distance of seventy-five miles—from forty-one miles above the Nore to twenty-seven miles above the earth's surface in the neighbourhood of Henley-on-Thames. On the average of four separate accounts, estimated by different observers between four and ten seconds, the time taken by the meteor to travel the entire distance, about seventy-five miles, was six seconds and a half. On this estimate the velocity of the meteor relatively to the earth's surface was about eleven miles per second. The direction of the actual position of the meteor's flight was from a point in the neighbourhood of the constellation Taurus, between Taurus and the head of Cetus.

The distance of the meteor at the moment of its disappearance from Wimbledon, collectively determined from these accounts, is about thirty-six miles. At Wimbledon, Mr. F. C. Penrose heard a loud report, like that of a cannon fired off at the distance of some miles, distinct enough to be heard very plainly by one other person at Wimbledon, about two minutes and twenty seconds after the meteor disappeared. Sound, with its ordinary velocity of 1,090 feet per second in common air, would take two minutes and fifty-four seconds to travel the entire distance of thirty-six miles from the point of the disappearance of the meteor to Wimbledon. Considering, as before, the difficulty of fixing the exact position of the apparent path of the meteor, and hence the approximate nature of the real path concluded from the independent statements of the observers, the agreement of the calculated time with the time observed by Mr. Penrose, between the disappearance of the meteor and the occurrence of the sound, must be regarded as a near coincidence. There can be little doubt from this circumstance—from the nature of the sound, the great apparent brightness of the fire-ball, and from its near approach to the earth—that this meteor was really a detonating fire-ball.

Detonating meteors are described in the British Association Reports as having taken place in England during the last five years, very nearly on the same date of the year as the meteor of the 21st of November, 1865.

The epochs of the 9th–11th of February, and the 19th–21st of November are, therefore, dates deserving special attention, partly with a view of determining for the future the directions of the detonating meteors, and partly as showing, by their frequent return within very narrow limits of time about these dates, that aërolitic meteors, like the acknowledged star-showers of August and November, revolved in fixed orbits round the Sun.

In a note on the spectrum of the variable star α Orionis, W. Huggins, F.R.S., and W. A. Miller, M.D., LL.D., F.R.S., mentioned an important change which has been recently observed in the spectrum of this star. α Orionis is a variable star of great irregularity, both of period and of extent of change of brightness. These observers have recently found that the group of lines, and "shading as if of fine lines," terminated at its more refrangible end by the strong line No. 1069·5 in their diagram, is not at present visible in the spectrum of the star. The absence of this group is of great interest in connection with the variability of the star's light, especially as the time of disappearance of this group coincides with the epoch of the maximum brilliancy of the star.

Mr. Baxendell, whose successful prosecution of this branch of astronomy is so well known, mentioning this star, says:—"The variable α Orionis is irregular both in the extent of its variation and the duration of its period. I have often thought its light was at times variable in colour as well as intensity, being sometimes perceptibly more ruddy than at others."

The variation in colour, so well described by Mr. Baxendell, corresponds exactly to the change in colour of the star which would be produced by the absence or presence of the group of lines referred to above, since the position of this group in the spectrum is about the boundary of the "orange" towards the "yellow."

The Astronomer Royal read an important and interesting paper "On the supposed possible Effect of Friction in the Tides in influencing the Apparent Acceleration of the Moon's Mean Motion in Longitude," in reference to a communication to the Institute of France by M. Delaunay, in which he explains a portion of the apparent acceleration of the Moon as possibly due to a real retardation of the rotation of the earth, and conceives that such retardation may possibly arise from friction in the tidal movement of the waters. In suggesting this explanation, he lays down as fundamental theorems the two following:—First, that if the solid globe of the earth were covered with water, there would be high water under the Moon (considered as the only tide-producing body); secondly, that the effect of friction would be to make the semi-diurnal tides later than they would be if there were no friction.

Any treatment of the tides is, necessarily, very imperfectly applicable to the real motion of the waters, under all their complicated circumstances of unsymmetrical boundaries, varying depths, and unknown laws of friction. Still attempts have been made upon different hypotheses admitting of mathematical treatment, by which the different points of M. Delaunay's theory may be tested.

Newton, Laplace, and Airy agree in this, that there will be low water under the Moon. In a subsequent part of the 'Principia,' Newton thinks that the high water would in some measure follow the Moon's place.

Airy shows that the effect of friction is to accelerate the time of each individual tide.

It is a result of this friction that the velocity of the earth's rotation is not affected.

It is a further result of this friction, and the consequent disturbance of the form of the waters, that the Moon's motion is affected; her orbit is made to become large, and her motion in longitude is retarded. The phase of low water (and consequently of the tide) is accelerated by the friction. Amongst the conclusions arrived at in this elaborate memoir are the following:—The friction of the tides does not tend at any instant either to accelerate or to retard the rotation of the solid globe. The friction of the tides produces a retardation of the Moon's mean longitude.

It would seem probable that the reaction of these forces will in some way produce a retarding effect on the earth's rotation. There are other instances in the lunar theory in which the Moon's action on the equatorial protuberance of the earth is accompanied by action of that protuberance on the Moon, both producing well-recognized effects. But in a case like this before us, where the very existence of the force depends on friction, and consequent disturbance of the law of *vis viva,* the author does not profess himself able to follow out all the consequences. It will probably be difficult to say what is the effect of friction in more complicated cases. Conceive, for instance (as a specimen of a large class), a tide-mill for grinding corn. The water which has been allowed to rise with the rising tide is not allowed to fall with the falling tide, but, after a time, is allowed to fall, thereby doing work and producing heat in the meal formed by grinding the corn. It is not doubted that this heat is the representative of *vis viva,* lost somewhere, but whether it is lost in the rotation of the earth, or in the revolution of the Moon, Prof. Airy is quite unable to say.

In an addendum, dated April 5, the Astronomer Royal says he has at length discovered two terms which appear to exercise a real effect on the rotation of the earth. By a process of mathematical reasoning, he proves that there is a constant acceleration of the waters as following the Moon's apparent diurnal course. As this is opposite to the direction of the earth's rotation, it follows that from the action of the Moon there is a constant retarding force on the rotation of the water, and therefore (by virtue of the friction between them) a constant retarding force on the rotation of the earth's nucleus.

The author concludes by saying:—"I am very happy to give my entire assent to the general views of M. Delaunay on the existence of one real cause for the retardation of the earth's rotation."

C. G. Talmage, Esq., gives an account of a probable observation of Biela's comet. He states that while sweeping for Biela's comet, on the 4th of November last, he came upon a nebulous object which is thought very likely to have been the comet. From brief opportunities afforded to Mr. Barber and Mr. Hind, it is very probable that Mr. Talmage's object was really nucleus *L* of this comet. Unfortunately the weather was too unfavourable to allow of subsequent observations.

Mr. Huggins, F.R.S., has contributed an interesting paper on "The Bright Granules of the Solar Surface," to which we shall refer in our next number.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

Russia.—The 'Bulletin of the Imperial Society of Naturalists at Moscow,' vol. xxxviii., No. 3, 1865, contains fourteen short botanical papers, morphological, anatomical, and physiological, by Paul Reinsch, with two plates of microscopic drawings delineated from nature, which are very valuable contributions to science. As the plants which have furnished the illustrations are familiar and easily obtained, the observations of M. Reinsch may be readily verified. Four of these papers are devoted to the subject of vegetable cyclosis, or the motion of the protoplasmic currents in the individual cell. The plants and the parts in which M. Reinsch has observed cyclosis, and which have furnished the beautiful illustrations of the first plate, are—1. The cilia on the leaves of *Sempervivum tectorum*; 2. The youngest developing cells in the whorls of *Nitella syncarpa*; 3. The individual cells of the root and parenchyma of *Hydrocharis morsus rana*; 4. The cells of *Closterium lunula*. M. Reinsch describes three kinds of cyclosis, *viz.* the rotatory movement which is confined to one portion of the cell; the circulatory movement, where the proto-plasmic current sweeps around the entire circumference of the cell; and the rotato-circulatory, which is a combination of the two preceding movements. The rate of motion in the cells, or parts of cells, is variable, being accelerated and retarded by a rise or a fall of temperature. The quantity of protoplasm in the current is also variable. The remainder of these papers consist of interesting articles "On the reproduction of Bryum by axillary buds;" "On the Infusoria in the cells of Sphagnum;" "The development of the Stellate cell in the pith of the Cyperaceæ;" "Acrosyncarpia in *Bryum cæspiticum*," being an abnormal development of the sporangium; "The antheridia of *Nitella syncarpa*;" "The reproduction of *Tetraspora lubrica*," of a new species of *Staurastrum*, and also of those familiar Desmids, *Euastrum margaritiferum*, Ehren., and *Cosmarium cylindricum*, Ralfs.; and, lastly, a paper on the development of the spores of *Scapania nemorosa*, Nees.

FRANCE.—*The Influence of Light on Plants.*—The Parisian Academy of Sciences have received a highly interesting communication from M. Duchartre on certain well-known plants, which, too weak to support themselves, tend to twine around the nearest objects. They generally do this from left to right, that is, inversely to the motion of the sun, but some species turn in the contrary direction, and it is impossible to make either the one or the other change its direction. Palm, Von Mohl, Dutrochet, and latterly Darwin, have successively expressed the opinion that light was the cause of this tendency; but further experiments being wanting to confirm this theory, M. Duchartre, who had discovered that the Chinese yam could live a long while in the dark, resolved to try the effect of absence of light upon it. At the end of May last he placed one in a pot, and as soon as it showed its stem above ground he took it down to a cellar, where it remained in complete darkness until the 2nd of August following. The stem, in the course of seven weeks, grew to the length of a metre and a half. It looked withered and whitish, but was upon the whole strong and even stiff and perfectly straight, showing nowhere a tendency to twine itself round the stick which had been placed there for its support. Another yam was planted nearly a month later, and left exposed to daylight until it had twined itself twice round its stick. It was then taken and placed in the cellar, where its stem, still obeying its natural tendency, went round once more, but in a more vertical direction than before; after which it grew straight up along its pole, to which it was fastened as it grew. It was now again taken up into the garden, where it immediately began to twine round again, making five close turns; and when it was once more taken down into the cellar it continued its growth again in a straight line, and so on, according as it was alternately in the light or in the dark. The same phenomenon was observed, not only in the yam or *Dioscorea Batatas*, but also in the *Mandevillea suaveolens*; but, on the other hand, the bean and the *Ipomæa purpurea* continue to twine round their supports in the dark.*

In the 'Bibliothèque Universelle' of the 25th of March, 1866, there is a "Note on some new facts in Botanical Geography" by Edmond Boissier, from which we learn that there are certain plants whose congeners inhabit very distant regions, which have recently been discovered in Europe and Asia Minor, and which may be truly regarded as disjointed species. The first is the *Dioscorea Pyrenaica*, Bub., found by M. Bubani, an Italian botanist, on the Pyrenees. The genus Dioscorea is very numerous in the tropics, only a few species having been found in the temperate zones—for example, the *Dioscorea villosa*, L., in the United States, and the *Dioscorea Batatas* in Japan. No European species was known until this one was found in the Pyrenees by M. Bubani.

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* 'Galignani's Messenger.'

Another curious fact is the discovery by M. Kotschy of a Pelargonium in the Taurus mountains in Cilicia, the same plant having been subsequently found along the whole chain from Pamphylia to Armenia. The Pelargoniums, which include the so-called Geraniums of our conservatories, were supposed to be exclusively indigenous to the Southern hemisphere, most of the species inhabiting the Cape of Good Hope, and a few Australia.

The third case mentioned by M. Boissier is that of a Pilostyles, a parasitic plant which grows in great abundance upon the branches of a leguminous plant, described as an Adesmia, and which Bolero collected in Chili. This plant has no root, stem, or leaves, its flower is campanulate, about two lines in diameter, and sessile upon the bark of the Adesmia, the epidermis of which it tears during its development. It belongs to the family Rhizantheæ, and is, in fact, a miniature representative of the gigantic Rafflesia Arnoldii of Sumatra. Another species of the same genus was discovered by the naturalist Pohl growing upon the branches of a Bauhinia in the forests of Brazil. M. Boissier, in examining a fascicle of dried plants brought by M. Haussknecht from the mountains of the east of Asia Minor, found the branches of a spiny Astragalus covered with a Pilostyles, which on examination he determined to be a new species. M. Boissier calls it the *Pilostyles Haussknechtii*, and it completes a genus hitherto known only from South America, and of which, singularly enough, all the species are parasitic on leguminous shrubs. The Pilostyles is a diœcious plant, and so far only the male plant has been found, the female flower remaining still to be discovered.

It would be easy to enlarge this list of disjointed species—that is, of species growing isolated in botanical regions far distant from the rest of their family or genus. Take, for instance, the well-known fact that there is in the floras of Southern Europe only a single myrtle and a single laurel, whilst numerous genera and species of these shrubs inhabit the tropical and sub-tropical countries of both continents. "If, however," as M. Boissier suggests, "we consider that, in the Tertiary period, the myrtles and laurels were diffused in Central Europe, we get a glimpse of an explanation, being led to assume—as has been so well shown by

M. Alphonse De Candolle in his 'Géographie Botanique'—that species are of different antiquities, and to hope that as our knowledge of the floras of preceding geological epochs becomes more complete, it will by degrees make us better understand the present distribution of plants."

It appears that M. Reveil, recently deceased, sent for competition to the French Academy an essay "On the Action of Poisons on Plants." According to his observations, not only mineral but organic acids, as citric and tartaric acids, in dilute solution, will cause the death of the plant which absorbs them. It is the same with several saline solutions and mixtures much diluted with alcohol and ether, which may be absorbed with impunity by animals. The committee to whom this paper was submitted, have marked their appreciation by the award of an honourable mention.

SCOTLAND.—*Vegetable Nosology.*—This important but little understood part of Botany is attracting some attention. At the meeting of the Botanical Society of Edinburgh, Dr. Lauder Lindsay read a paper "On the Diseases of Plants in connection with Epidemics in Man and Animals." The 'Lancet' of the 14th of April also contains an abstract of Dr. Salisbury's views and experiments on the Cryptogamic origin of disease. The fungoid origin of disease is no new opinion. Eight years ago, the late Dr. Mitchell, of Philadelphia, published a pamphlet on this subject, which was very favourably received. The prevalence of certain diseases amongst plants, produced by microscopic fungi, and at the same time of certain infectious diseases amongst animals, was known even in the middle ages. The course which investigation has recently taken on this subject will doubtless lead to discoveries of great value.

At the same meeting Dr. McNab contributed a paper "On the Development of Leaves." He reduces them in all their varieties of form to seven types—1. Basifugal, or leaves with the leaflets developing first at the base; 2. Basipetal, the leaflets developing first at the apex; 3. The Cyclical type—leaflets developing in a circle, ex. Lupinus; 4. The Divergent type—the central leaflets developing first, and those of the apex and base last; 5. The Simultaneous type—all the leaflets developing together; 6. The Ternate type—ex. Thalictrum, Aquilegia, &c.; 7. The Parallel type. Dr. McNab thinks that both simple and compound leaves belong to these types, the difference being merely one of degree of development and not of type.

We append to these views of Dr. McNab the following synoptical table of the types of nervation of leaves taken from the 'Physiotypia Plantarum Austriacanum' of Professors Ettinghausen and Pokorny, a work recently published by the Austrian Government, as likely to prove interesting to English botanists.

I.—*Forms of Nervation, with a single Primary Nerve.*

1. Nervatio Camptodroma. Bowed or inflected nervation. *a.* Dictyodroma—netted; ex. Willow. *b.* Brochidodroma—looped; ex. Circæa. *c.* Veræ—True; ex. Rhamnus.
2. Nervatio Craspedodroma. Marginate nervation. *a.* Simplices—simple; ex. Fagus, Castanea. *b.* Compositæ—compound; ex. Polemonium cæruleum.
3. Nervatio Hyphodroma. Concealed nervation; ex. Coniferæ.

II.—*Forms of Nervation, with several Primary Nerves.*

4. Nervatio Parallelodroma. Parallel nervation; ex. Grasses.
5. Nervatio Campylodroma. Curved nervation; ex. Musaceæ.
6. Nervatio Acrodroma. Convergent nervation. *a.* Perfecta; ex. Convallaria. *b.* Imperfecta; ex. Arnica.
7. Nervatio Actinidroma. Radiated nervation. *a.* Reteformis—netted; ex. Nepeta. *b.* Imperfecta—imperfect; ex. Urticæ. *c.* Marginales—marginated; ex. Acer.

March 8.—The Botanical Society of Edinburgh were presented by Dr. Carrington with specimens of *Scapania Bartlingii*, Nees, a species of Hepaticæ new to Britain. May 10.—Captain M. Norman, R.N., Madeira, read before this Society a paper "On the Effect produced on the Operator by the Poisoning of Plants in a Herbarium." In consequence of using an alcoholic solution of camphor and corrosive sublimate in poisoning his Madeira plants, Captain Norman had suffered twice from severe salivation. It appears that the plants were kept in a room much frequented by him, and being thus under the influence of a mercurialized atmosphere, he had suffered in the way he described. In the conversation which ensued after the reading of this paper, it was stated that none of the operators, engaged in poisoning plants for the herbarium of the University of Edinburgh, had experienced any inconvenience. Mr. Gilbert Stuart said that he had slept six months in a room where poisoned plants were kept, and had not felt any bad consequences. The only inference that could be deduced from these facts was that Captain Norman, and probably others *similarly* organized, are peculiarly susceptible to the effects of mercury.

America.—The manufacture of white paper from wood is now quite a success at the Manayunk wood-pulp works, Pennsylvania, N. America. The wood used is that of the *Liriodendron tulipifera*, L., or Tulip poplar, and the *Abies Canadensis*, Michx, or Hemlock spruce. It is brought to the works as ordinary cord wood, and is cut into chips by means of two immense machines, having cutters attached to rotatory discs, capable of cutting from thirty to forty cords of wood in twenty-four hours. These chips are conveyed in wagons to the boiling-house, and placed in boilers, where the reduction to pulp is effected. The pulp thus reduced is then conveyed to pulp-engines, is worked in these engines, and run through cleaning machines. From the cleaning machines the pulp is taken to the bleaching-house. After having been bleached, it is then ready to be made into paper—in the same way as any other pulp. Excellent white printing paper very good for newspapers, and at a price of three cents per pound less than is charged for the same quality of paper made from rags, is manufactured from this pulp by Martin Nixon, at the Flat-rock paper-mills, adjacent to the pulp works. The wood-pulp must, however, be mixed with about twenty per cent. of straw-pulp, this mixture improving the quality of the paper. These works have been so successful, that the price of paper for newspapers has declined three cents per pound since they have been in operation. This is a very great step in the progress of those arts which contribute so greatly to our comfort and civilization.

ENGLAND.—At the meeting of the Royal Horticultural Society, held on the 1st of May, at South Kensington, Mr. W. G. Smith exhibited a fine specimen of *Morchella crassipes*, Kromb., a species entirely new to Britain. This plant is admirably figured by Klotzsch in Krombholz's magnificent work on 'Fungi.' It was found in red soil by Miss L. E. Lott, at King's Kerswell, near Newton Abbot, Devonshire, at the end of April last.

OBITUARY NOTICE.—English science has sustained a severe loss in the death of Dr. W. Harvey, F.R.S. and L.S., Professor of Botany in Trinity College, Dublin, and well-known by his valuable works on 'Algæ,' and on the 'Botany of South Africa.' Dr. Harvey died on the 15th of May, of phthisis, at Torquay, whither he had repaired for the benefit of his health.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

BUT few additions of general and popular interest have been made to the knowledge of chemical science since our last publication. M. Baudrimont has made some curious experiments illustrating the Allotropism of oxygen. It is well known that when hydrochloric acid reacts on binoxide of barium, binoxide of hydrogen is produced, while by the action of the same acid on binoxide of manganese chlorine is set free. It seems clear, then, that chlorine has more affinity for barium than for the oxygen that peroxidizes the barium; while the contrary is the case with the manganese and the oxygen which peroxidizes it. This may be demonstrated by filling a bottle with chlorine and introducing some finely-powdered binoxide of barium mixed with a little water. An active effervescence ensues, and after a time the chlorine will be found to have disappeared, its place being taken by oxygen, which, however, will not affect ozone paper. Another difference between the two metallic peroxides is also mentioned. Sulphovinic acid when heated with binoxide of manganese yields aldehyde; but when heated with binoxide of barium it yields oxygen, olefiant gas, ether, and sulphurous acid. Binoxide of hydrogen prepared from binoxide of barium is decomposed by binoxide of manganese. M. Baudrimont states that he has succeeded in preparing binoxide of hydrogen from binoxide of manganese, which is decomposed by binoxide of barium. And further, the two oxygenated waters from these different sources when brought together mutually destroy each other. The author also states that when oxygenated water is submitted to the action of the battery, equal volumes of hydrogen and oxygen are obtained, showing that the binoxide of hydrogen is decomposed in preference to the water. M. Baudrimont speculates reasonably enough that all bodies may exist in two allotropic modifications. Hydrogen, for example, giving, as we have seen, two distinct binoxides, it is probable that it is present in distinct and complementary states in those oxides.

Some new compounds of sulphur and carbon have been obtained by O. Loew. Sesquisulphide of carbon is an amorphous brown body, which decomposes into its constituents when heated to 210° C., indicating a loose state of combination of the elements. A hydro sesquisulphide of carbon is also a brown amorphous body, having a faint odour of garlic. When this body is boiled with alkalies it gives oxalic acid and lower sulphides of carbon. By acting on a chlorine compound of hydro-sesquisulphide of carbon dissolved in bisulphide of carbon, with a solution of bromine in bisulphide, the author obtained a body which appeared to be monosulphide of carbon, but found it impossible to procure the compound perfectly pure.

Among the novelties in organic chemistry, we may first allude to the discovery by Drs. Bence Jones and Dupré of a substance resembling quinine in all the tissues of the body—resembling quinine, that is, in being precipitable by the same reagents, and in being possessed of the property of fluorescence. About the chemical composition of the substance nothing is as yet known or has been made public. The substance is obtained by first treating the animal matter with a dilute acid, then neutralizing the acid solution with an alkali, and subsequently extracting the fluorescent substance with ether. Not having as yet obtained the substance in a crystalline form, the discoverers have provisionally named it Animal Quinoidine. It deserves to be mentioned that the experiments undertaken in the course of this research showed the extreme delicacy of the fluorescence test for quinine itself. The author found that a grain of quinine dissolved in one million eight hundred parts of water showed the blue fluorescence distinctly in twenty grains of the solution. For further information on this very interesting matter, we may refer the reader to Dr. Jones's lecture.*

M. Berthelot's continued researches on Acetylene have led him to the important discovery that at high temperatures various hydrocarbons will combine with each other, and with hydrogen to form higher carbides of hydrogen; and have also suggested to him a new theory of the origin of petroleum. Daubrée has speculated that the alkaline metals may exist in the free state in the centre of the earth. Carbonic acid, M. Berthelot states, is everywhere infiltrated in the crust of the earth, and may come in contact with the alkaline metals at very high temperatures. In this way acetylides would be formed. The same acetylides, he states, would also be formed by the contact of alkaline metals with earthy carbonates below even a dull red heat. By the action of steam the alkaline acetylides so produced would set free acetylene, and this body being unable to exist under the conditions in which it must be placed, we obtain instead the products of its condensation, bodies allied to petroleum and bitumen.† This view of the formation of the natural carbides of hydrogen, by purely mineral reactions, will no doubt attract much attention from chemical geologists.

While speaking of the carbides of hydrogen, we must not omit to mention the discovery by Mr. Schorlemmer of a new series in that still unexhausted mine of discovery, coal-tar. These bodies are still under investigation, and we shall probably have to refer to them on another occasion.

In analytical and technical chemistry we have observed nothing that requires a notice.

In chemical literature a few useful books have appeared. Mr. H. Spencer, B.A., has published a very useful book, 'Elements of Qualitative Chemical Analysis,' which is unfortunately disfigured by a large number of errata, not all of which are corrected in the long table at the beginning of the work. This is a great fault in a book intended for beginners, who will seldom take the trouble to make the corrections before they commence to use the book. One very useful feature in the work is the explanation of all the reactions by equations. It need only be added, that the symbols and equations are expressed in the new system of notation, which alone will give the work a value in the estimation of many.

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* 'Chemical News,' April 27, 1866.

† 'Comptes Rendus,' lxii., p. 949.

A new edition of Bowman's 'Practical Chemistry,' edited by Mr. Bloxam, has been issued. In this edition the editor has omitted the symbols and equations; but at the same time he has contributed considerably to the practical value of the work by rearranging and adding to the analytical part.

A 'Report of the Proceedings of the Chemical Department of the Highland and Agricultural Society of Scotland,' made by the chemist to the Society, Dr. Anderson, deserves the attention of agricultural chemists. In it Dr. Anderson shows, in opposition to Liebig, that the manurial value of uric acid is quite equal to that of the other nitrogenized ingredients of Peruvian guano. There is also a very useful paper "On the Growth of the Bean Plant," and another "On the Adulteration of Oil-cake."

PROCEEDINGS OF THE CHEMICAL SOCIETY.

On March 1, Professor Church made a communication "On New and Rare Cornish Minerals;" and Mr. J. A. R. Newlands read a paper, entitled "The Law of Octaves, and the Causes of Numerical Relations among the Atomic Weights."

Professor Wanklyn described "A New Method of Forming Organo-metallic Bodies." A paper, by Mr. C. Wright, "On the Action of Sunlight upon Sensitive Photographic Papers," was also read. The author has made an extensive series of experiments in order to determine the relative sensitiveness of paper prepared with different reagents. His practical results are given in the following table:—

Paper prepared with	Chloride of Silver	1·000
,,	Chloriodide of Silver	1·078
,,	Chlorobromide of Silver	4·022
,,	Bromide of Silver	2·396
,,	Bromiodide of Silver	4·060

On March 25, Dr. Hugo Müller read a paper "On Hydrocyan-Rosaniline." When aqueous solutions of a salt of rosaniline and of cyanide of potassium are mixed, the red colour of the rosaniline salt is destroyed, and a white precipitate of the compound abovenamed is formed. The production of this compound affords, the author believes, the means of determining the commercial value of samples of rosaniline, the crystallization of which, he has found, to be no proof of purity.

At the same meeting, Dr. Frankland gave an account of "Metropolis Waters during the years 1865–66," founded upon the results of his monthly analyses. This, with a very useful account of the analytical methods adopted, will be found in the 'Journal of the Chemical Society,' for June, 1866.

At the next meeting, on April 5, Mr. J. Spiller read a paper

"On the Estimation of Phosphorus in Iron and Steel." The process usually adopted by analysts is that of Fresenius, which the author finds may be considerably curtailed without impairing the accuracy of the results. Following Fresenius as far as the partial reduction of the ferric solution by sulphurous acid, Mr. Spiller dispenses with the next step—precipitating the phosphoric acid with the remaining ferric oxide by boiling with acetate of ammonia—and adds sesquicarbonate of ammonia to the partially reduced solution until the precipitate, at first red, becomes greenish, showing the precipitation of some ferrous oxide. The temperature of the solution must not exceed 70° or 75° Fah. while this part of the operation is conducted. The precipitate being collected, is next dissolved in hydrochloric acid, and to the warm solution is added in succession citric acid, ammonia in excess, and sulphide of ammonium. By this means the whole of the iron is precipitated, and may be separated by filtration. The filtrate being slowly evaporated with full exposure to air, and the sulphur deposited removed, the phosphoric acid may be precipitated in the usual way.

Professor Wanklyn afterwards read a paper "On Magnesium," showing the ordinary magnesium ribbon of commerce to be remarkably pure, and pointing out the resistance offered by this metal to the action of chlorine, bromine, and iodine. The author also showed that magnesium-amalgam decomposes water with greater facility than sodium amalgam.

Mr. E. T. Chapman then made some observations "On Mercury-Ethyl," and Mr. W. A. Tilden read a paper, entitled "Further Contributions to the History of the Periodides of Organic Bases."

Mr. M'Leod afterwards exhibited an experiment, showing, on a large scale, the formation of acetylene by the incomplete combustion of marsh gas.* Mr. M'Leod employed the form of apparatus used by Dr. Hofmann to show the combustion of oxygen in hydrogen, ammonia, or coal gas, in the present experiment burning the oxygen (atmospheric air may be employed) in an atmosphere of marsh gas,† and causing the products of combustion to pass into an ammoniacal solution of cuprous chloride. Mr. M'Leod then showed the explosive properties of the characteristic red precipitate produced by acetylene in the copper solution, and hitherto called acetylide of copper, but the exact composition of which has not yet been made known. The author believes it to contain cuprous oxide in combination with the acetylide.

Dr. Hofmann subsequently made some observations "On the Synthesis of Guanidine."

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* 'Journal of Science' for April, p. 266.

† The apparatus will be found described in the 'Journal of the Chemical Society' for May, 1866.

On April 19, Professor G. C. Foster delivered a lecture "On the Thermal Phenomena accompanying Chemical Action;" and papers "On Picric and Oxypicric Ethers" were communicated by Drs. Stenhouse and H. Müller.

On May 3, Dr. J. H. Gladstone read some notes "On Pyrophosphodiamic Acid;" and Mr. R. Warington, junior, gave an account of his "Researches on the Phosphates of Calcium, and upon the Solubility of Tricalcic Phosphate." The latter showed that the solubility of the Tricalcic Phosphate was much greater in water containing chloride of ammonium, or saturated with carbonic acid, than in pure water.

At the meeting on May 17, several papers were read, of which we can only give the titles:—"On the Production of Acetic and Propionic Acids from Amylic Alcohol," by Mr. E. T. Chapman; "On the Oxidation of Ethylamine," by Professor Wanklyn and Mr. E. T. Chapman; "On the Action of Acids on Napthylamine," by Mr. Chapman. On the same evening Sir Robert Kane gave an account of "Some Derivatives of Acetone," and the Rev. T. Gibsone gave the outline of a criticism of "Dalton's and Gay Lussac's Formulæ for the Calculation of Vapour Densities." Afterwards a paper, by Mr. Hadow, "On the Nitro-prussides, their Composition and Manufacture," was read. The mode of manufacture proposed by the author is complicated, but its success was proved by a large and beautiful specimen of crystallized nitro-prusside of sodium exhibited at a previous meeting. For the production of this body the author first passes nitrous acid, formed by the action of nitric acid on starch, into a solution of caustic soda. A calculated quantity of this solution of nitrite of soda is then added to a mixture of acetic acid, ferridcyanide of potassium, and corrosive sublimate. A rather complicated reaction ensues, and the solution will contain nitro-prusside of sodium, cyanide of mercury, acetate and chloride of potassium, which may be separated by crystallization.

V. ENTOMOLOGY.

(*Including the Proceedings of the Entomological Society.*)

The devastation of a species of white ant in St. Helena was the subject of a communication from Mr. E. L. Layard, made to the Entomological Society at its meeting in May. Introduced in timber from the west coast of Africa, about twenty years ago, it had latterly become so destructive as to threaten the ruin of James Town. Everything made of wood was destroyed; the books of the public library had been devoured, the theological works being especially preferred, because, it is supposed, less used, and the insects, therefore, less disturbed in them than in the others. Partially Kyanized wood had been found ineffectual to prevent their eating through to the untainted part beyond; and tin-plate, owing to the corrosion of the metal from the probably acid secretion of the animals, afforded no permanent protection. So far the ravages had been confined to the town.

At a recent meeting of the Oxford Microscopical Society, Mr. Robertson exhibited some *Acari* obtained from the chest and abdomen of a common fowl, which had been killed for the purpose of dissection. They presented the appearance of small white specks on the peritoneum, and in the chest around the bifurcation of the trachea; they were also dotted over the surface of the lungs. All the *acari* had four pairs of legs.

We have lately received a work on Italian Entomology, published at Padua. It is entitled 'Entomologia Vicentina,' and comprises a list of insects of all orders found in the province of Vicenza, with descriptions of the commoner species. It is by the "Abate Francesco Disconzi," and forms a royal octavo volume of 318 pages and 18 plates. Such a work from the Italian press deserves to be recorded in the "Chronicles."

The Royal Society of Sciences of Liege has just issued the first part of Dr. Chapuis' monograph of the *Scolytidæ*, with excellent outline figures representing all the species. These are the insects—one of which is our well-known *Scolytus destructor*—which are popularly supposed to do so much injury to trees. There is little doubt, however, that they attack *exclusively* trees in a state of decay, and that therefore, as has been well observed by Mr. Wallace, they are to be regarded rather as benefactors, "teaching us, by their presence, that there is something wrong" than as enemies.

To those in want of a good and *reliable* work on our native Coleoptera, we would recommend Mr. Rye's 'British Beetles,' just published, with sixteen coloured plates—the best as to the drawing and engraving this country can produce; it is at ten-and-sixpence, a marvel of cheapness. If "not, in the common sense of the term, a popular book, it is, in fact, something much better," and it has the advantage over many popular books, of being written by one who understands his subject.

ENTOMOLOGICAL SOCIETY.

March.—At this meeting two Japanese collections of insects were exhibited, one by Mr. Stevens from Hakodadi, the other by M. Tegetmeier from Nagasaki, formed by a native. These and other collections clearly prove that Japan, like Northern Asia generally, derives the insect portion of its fauna from Europe, Several nests of the *Vespa sylvestris* were exhibited by Mr. F. Smith; many of these were interesting from their abnormal forms, the workers having been deprived of their queens. A large and important collection of insects was also exhibited by the Rev. O. P. Cambridge, made by himself in the Holy Land. This, it was understood, would form a portion of the materials to be used by the Rev. H. B. Tristram in his forthcoming work on the natural history of that country. In reference to a twig of a mulberry-tree sent from Saugor by Captain Alexander, on which were deposited a multitude of eggs of a species of *Ascalaphus*, Mr. McLachlan remarked on the statement made by Geoffroy that the *Myrmeleon formicarius* laid eggs which never produced anything; that these so-called eggs were the meconium, which, instead of being voided in a liquid shape, here took the form of egg-like bodies. A paper was read by Mr. Edward Saunders, entitled "A Catalogue of the *Buprestidæ* collected in Siam, by the late M. Mouhot." It comprised three new genera and thirty-three new species.

April.—A very curious arrangement of the eggs of a species of *Chrysopa* (?) from Australia was brought under the notice of this meeting by Mr. W. Wilson Saunders; they were arranged in a line on the bark of a tree, each egg supported on a stalk, the first, third, fifth, and so on, placed longitudinally and at right angles with the bark, while the intervening numbers were placed transversely at an angle of about 45°. Mr. Rogers sent for exhibition several individuals of *Pimpla oculatoria*, which he had bred from the egg-bag of a spider, on which it was parasitic. Mr. J. Jenner Weir exhibited some larvæ of the common meal-worm (*Tenebrio molitor*), which had done great damage in an extensive cellar by eating through the corks of bottles containing port wine, and thus allowing it to escape; they had also attacked the corks of the sherry bottles, but had invariably stopped short of eating through them. It was supposed that these larvæ had been introduced in the bran which had been used for packing the bottles. Mr. W. W. Saunders remarked that a quantity of manufactured corks in one of the London Docks had been destroyed by the larvæ of *Dermestes lardarius*, which were brought into the docks in a cargo of skins infested by these insects. Mr. F. Smith exhibited a specimen of *Bembex olivacea*, taken near Gloucester; the insect was figured as British by Donovan, but its claims as a British species have long been doubted.

May.—Mr. W. Wilson Saunders exhibited a very remarkable nest—supposed to be a spider's—from New South Wales, formed by bending a stout lanceolate leaf at certain definite angles into four portions, which, being cemented in some way at the edges, presented the figure of a nearly perfect cone; the base of the leaf constituted the floor, one side being left uncemented, evidently for entry and exit, and as this was underneath and skilfully protected by the side immediately above it, the whole must have been quite impervious to rain. Mr. Stainton exhibited a number of highly-finished drawings of the larvæ of various species of *Micro-lepidoptera*, collected at Cannes, and of their mining operations in the parenchyma of the leaves of the plants affected by them. Mr. Newman sent for exhibition some dead larvæ of *Hepialus lupulinus*. The interior of their bodies had been occupied by some species of fungus, which had sent out their mycelia in all directions through the skin. Mr. Janson exhibited *Throscus elateroides*, taken at Rochester, and new to Britain. Mr. E. L. Layard called the attention of the meeting to the devastation of the white ants at St. Helena. The Rev. Douglas Timmins contributed a paper entitled "Notes on the Insects of Hyères."

VI. GEOGRAPHY.

(*Including Proceedings of the Royal Geographical Society.*)

The newest discovery in geography must necessarily be that fresh distribution of land which has taken place since our last report. We are now speaking of physical distributions, for the political changes of Europe cannot well be chronicled in a scientific record until they are so well known to the world in general that they have lost all interest, whereas the works of nature, partaking, to some degree, indeed, of the capriciousness of human proceedings, still have a stability in themselves, or, at all events, excite so little hostility, that they may be set down at once as soon as they have taken place, without awaiting for the subsidence of the effervescence of their first appearance. The new distribution of land to which we refer, then, is not a partition of already existing territory among rival States, new boundaries to Denmark, Prussia, Austria, Italy, France, which will make antiquated the newest maps of Europe we have in our libraries, and will cause infinite perplexity to those who have to instruct the ingenuous youth from manuals, the result of careful filtering of standard works of some years back; but the actual redistribution of land and water in the Mediterranean by the appearance of a new volcanic island in the Bay of Santorin, an island in the Archipelago, about half-way between Europe and Asia, and a little way to the north of Crete. Thus this eruption, unlike political ones, is confined to the extreme south-eastern portion of the kingdom of Greece; but it resembles its prototypes to which we have referred in threatening destruction to the old whilst it promises that which is new.

The exploration of Palestine has proceeded with excellent success—maps have been corrected and improved, positions of many sites determined astronomically, a great number of important photographs prepared, two or three localities excavated, and steps taken towards the identification of some disputed sites. At the same time that much steady progress has been made, no startling discoveries have rewarded the labourers, and though the importance of all their discoveries cannot as yet be justly determined, nothing has yet transpired that would lead us to suppose that anything very new or very important has been brought to light. For some time past a series of papers have appeared in the 'Reader,' being translations of a "Note on the Formation of the Basin of the Dead Sea, and on the Changes which have taken place in the Level of the Lake," by M. Louis Lartet, a subject that belongs more properly to geology than geography, but which is important enough from both points of view to merit attention. Notwithstanding the tragical fate of Baron von der Decken, African exploration still continues to afford excitement to many travellers of various tastes and temperaments. The German Rüppel is on a journey to Abyssinia, in which undertaking he is assisted by a grant from the Senate of Frankfort. The fate of Englishmen, the survivors of the wreck of the St. Abbs Indiaman, supposed to be in captivity among the Somāli, has caused much excitement. Besides the means for their recognition mentioned below, the Rev. Mr. Rebmann, a missionary stationed at Rabbai Mpia, near Mombaz, has made several journeys into the interior, and meditates, if he can obtain further support, a more extensive search. Herr Gerhard Rohlfs intends to penetrate, if possible, to Wadai, with a view to recovering, if possible, the papers of Edward Vogel, who there met with his death. A former servant of Vogel's, and an eye-witness of his death, promises to accompany him.

Professor Lepsius, too, has gone to the northern coast of Africa, and has been fortunate enough to meet with a tablet of the same sort as the Rosetta Stone—*viz.*, an inscription in hieroglyphic and demotic characters, accompanied by a Greek translation, which will no doubt give additional confirmation and assistance to Ægyptologists. Besides these travellers, the Roman Catholic missionaries have published several works on the languages of Central Africa. The latest of these was published at Brixen, on the great pass from the Tyrol into Italy, and consists of a grammar and dictionary of the Dinka tongue.

The travellers educated in Africa (if we may so speak of the later life of one of these) carry into other continents the research and perseverance they have acquired in that remarkable quarter of the globe. Captain Burton, whose African exploits have made us almost forget his Asiatic deeds, has found a new sphere in South America. He has traversed the Rio Iguipe, and having discovered a volcano in a district (Brazil) hitherto considered devoid of these phenomena, he is intending, as soon as the weather will permit him, to continue his research. Further north, General Lyon, of the Southern States, has discovered one of the ancient cities of Mexico, the ruins, just as they were deserted, being surrounded and blocked up by trees.

We have to announce the death of Mr. John MacDougal Stuart, the explorer of a large portion of the Australian continent. After two journeys into the interior, he succeeded in crossing from Southern Australia to the north coast, a feat acknowledged by substantial grants from the colonial legislature, and Honorary Fellowships of the Royal Geographical Society of London, and that of Berlin.

PROCEEDINGS OF THE ROYAL GEOGRAPHICAL SOCIETY.

A trustworthy account of the barbarous murder of Baron von der Decken, concerning whose fate we were in doubt when our last report was written, has been received through the British Consul at Zanzibar, Colonel Playfair. It will be remembered that the Baron had left his party in charge of a wrecked steamer, and had gone back to Berdera with Dr. Link. The camp in which this party remained was attacked by a band of Somāli, and Lieutenant Schickh, and those under his command, were compelled to descend to the coast, whence they hoped to send assistance to the Baron. In the meantime the latter lost his boat, and was separated from his companion. Both attempted to return to the wreck, in which attempt the Doctor was successful; but each was surrounded by the natives and barbarously murdered. The murderers are far from all European influence, and consequently not amenable to justice. The Sultan of Berdera is supposed to have connived at this cruelty. In connection with this subject a paper, by Colonel Rigby, was read on Englishmen in captivity in Somāli land, in which it was stated that there was a great probability that some of the crew of the St. Abbs Indiaman were still living in bondage among this people. It has since been announced that the Political Resident at Aden has commissioned a very intelligent Somāli, who has been interpreter in the police court, to return to his native country and determine positively whether any Europeans are there or not.

"Travellers' tales" have become proverbial for their untrustworthiness; but much as we are apt to distrust the accounts of men who have journeyed over ground not hitherto traversed, it is seldom that we find a case so glaring as that detected by Sir H. Rawlinson, of a lengthy account of a journey that was never undertaken. In a paper, entitled "Observations on a Memoir recently published by M. Veniukof, on the Pamin Region in Central Asia," Sir H. Rawlinson proved tolerably satisfactorily that M. Veniukof and the Russian geographers, as well as Kiepert and Stanford, had published maps and accounts of a little-known region lying between the northern frontier of Kashmir and the south of the Russian empire, mainly in reliance on a MS. journal of travels, discovered in the archives of the Military Topographical Depôt at St. Petersburg, purporting to be written by a German gentleman named Georg Ludwig von ——, who had been employed by the East India Company to purchase horses for them, but which MS. journal was a groundless forgery. The original work is described to be elaborately furnished with maps and sketches, to be accompanied by a French translation (in a separate volume) of the German original. The mention of an active volcano, north of Srinagur, in a well-surveyed province, where no such volcano is known—the traversing 120 miles of difficult mountainous country in two days, and other improbable distances—the mention of a Lieutenant Harvey, whose existence is unknown to the Indian Army List—the want of agreement of names with any that are known—the omission of the mention of Yaks or wild goats, and the mention of black rabbits, as yet unknown in Central Asia, with many other improbabilities, make the authority of the MS. rather more than doubtful.

The Leichhardt expedition into the interior of Australia has met with some reverses in the loss of all its horses, and in sufferings amongst the explorers from drought. The camels, however, survive, and the expedition will continue its work.

The Peninsula of Sinai has been well surveyed around its coast and in a line across its northern boundary, by the Rev. F. W. Holland, who holds opinions different from those of most travellers on the subject of the passage of the Israelites. In an interesting paper on the subject, the author described various roads, ruins, &c., discovered by him in unfrequented localities, bespeaking a period of considerable population and civilization in the interior of this now deserted peninsula.

The Sinaitic inscriptions and ancient turquoise mines (some of which have been mistaken for copper mines) yielded him some important results, and might be expected to produce more, if they were fully and carefully investigated. Owing, we suppose, to the influence of a prominent member of the Geographical Society, who constantly views with suspicion the politics of this region, Central Asia contributes a considerable share to the Proceedings. Captain T. G. Montgomerie, R.E., contributed a paper on a subject with which he was not personally acquainted—"The Geographical Position of Yarkund and other places in Central Asia." The circumstance which led this gentleman to be interested in this subject has been his employment in the trigonometrical survey of India by the Government; and whilst in this position he endeavoured to extend his knowledge beyond the limits of the country assigned to him. Whilst occupied in this manner he succeeded in becoming acquainted with a Moonshee, named Mohammed-i-Hameed, sufficiently instructed to be able to work ordinary surveying instruments and willing to convey those entrusted to his charge as far as was required of him. This man started and accomplished the main objects of his mission; but, unfortunately, was unable to return. He died within a short distance of the termination of this journey. His papers, however, were conveyed to Captain Montgomerie, who has obtained some very important results from them. Yarkund has proved to be in latitude 38° 19′ 46″; longitude, 77° 30′ E., and at an altitude of 4,000 feet; the distance from Jummoor is said to be 430 miles, so that the narrowest breadth of this portion of the Himalayan range cannot be estimated at less than 400 miles, a distance that it took the Moonshee fifty-one days to traverse, forty-five of which were spent at a greater elevation than 9,000 feet, and twenty-five at not less than 25,000. The climate seems to be severe; the mass of the people Mahommedan, though under Chinese rule.

Commander Forbes furnished a paper "On a Journey to the Western Shore of Volcano Bay in Yesso," which described the volcanic phenomena of this northernmost island of the Japanese empire, and gave an account of the Ainos, a race of hairy men supposed by some to belong to a different and more aboriginal race than the present Japanese, a position Professor Huxley to some extent controverts on the authority of similar conformation of skulls, which, though elongated, are distinct from the Esquimaux, and altogether unlike the crania of the races of Eastern Asia.

Other papers and communications read before the Society have been—"On the Settlement of Lukoja on the Niger," by Mr. T. Valentine Robins; A letter from Commodore Eardley Wilmot, Commander-in-Chief of the West African Station, "On the Niger Settlement;" "A Description of Peking," by Mr. W. Lockhart, M.R.C.S.; "On a Visit to Dana, in Tibet," by Captain A. Bennet.

At the anniversary meeting of the Society, the medals were awarded as follows:—The Founder's, to Dr. Thomas Thomson, M.D., for his exploration of the Western Himalayas and Thibet, and for his work thereon; the Patron's, to Mr. William Chandless, M.A., for his survey of the River Purus. M. Du Chaillu received one hundred guineas to reimburse him for the loss of his instruments in Western Africa.

Sir Roderick Murchison delivered a lengthy address, which alluded first to the deaths of Fellows during the last year. He then described the advance made of late in chartography and meteorological observation and registration. Dr. Livingstone has arrived at the mouth of the Livuma River, whence he will advance into the interior, to supplement, and as far as possible reconcile, the discoveries of Speke, Grant, Burton, and Baker. Mr. Whymper, of Matterhorn celebrity, accompanied by a well-trained Danish guide, is meditating a trip to the glaciers of the interior of Greenland. Central Asia is receiving much attention at the hands of Russian geographers, especially in the neighbourhood of the mountains lying between Little Thibet and Turkistan, a range which, for 450 miles, has peaks rising from 21,000 to 28,300 feet above the level of the sea.

VII. GEOLOGY AND PALÆONTOLOGY.

(*Including the Proceedings of the Geological Society.*)

We cannot pretend to chronicle this quarter a very extensive list of new and important discoveries; but some few real advances have been made, and several questions of theoretical interest are still under discussion.

To begin, Dr. E. Percival Wright has made public the remarkable results of a systematic search for fossils at the Jarrow Colliery, Kilkenny, the expense of the exploration having been defrayed by a grant from the British Association. Professor Huxley and Dr. Wright have been able to distinguish in the collection made, species of no less than six genera of Labyrinthodonts, of which at least five, named respectively *Urocordylus*, *Ophiderpeton*, *Ichthyerpeton*, *Keraterpeton*, and *Lepterpeton*, are new, while the sixth may be the known genus *Anthracosaurus* of the Glasgow coal-field. The authors therefore justly remark, that "one Irish coal-pit has thus yielded, in the course of a few months, by careful exploration, more genera than are known from all the American coal-fields, and nearly as many as have been obtained from Europe generally." Besides these genera, however, there are indications of the existence of several others, as well as a large collection of fish-remains, including a new genus of ganoids, which is to receive the name of *Campylopleuron*. It appears that Ophiderpeton may be taken to represent either the type of *Amphiuma* or that of *Cæcilia* amongst existing Batrachia, while the rest fall into the salamandroid division, the better known genus *Archægosaurus* being the ancient representative of the Perennibranchiata. Consequently the tailless froglike form is the only one now unknown from Carboniferous strata, and, curiously enough, that is precisely the form in which the original genus Labyrinthodon was erroneously restored at the time of its discovery.

The recent eruptions in the neighbourhood of the Kaimeni Islands have afforded material for numberless newspaper paragraphs, and an excellent excuse for an agreeable trip to some half-dozen geologists and an untold number of tourists; but we are not aware that they have contributed much to our knowledge of volcanic phenomena. Heaps of lava, a new fissure, and even two new islands, though startling enough to those living in their immediate vicinity, have no special interest for the geologist, and those men of science who have visited the spot have either discovered very little of theoretical importance or have not yet made their discoveries known. We must, however, notice the report of M. Fouqué to the French Academy of Sciences, by which learned body he was sent to Santorin. From what he writes, it appears that neither the newly-formed George promontory of Nea Kaimeni nor the new island of Aphroessa is a true crater, but merely a heap of lava; that the eruptions have been on a very small scale and of an insignificant degree of intensity, and that the terror of the inhabitants was to a great extent created through the burning of a ship and the death of its captain by volcanic action. M. Fouqué also records the appearance of another new islet, to which he gave the name of Réka, situated in a line with the George promontory and the island Aphroessa. In consequence of the disengagement of combustible gases mixed with salts of soda from the lava of Aphroessa, that island has generally been enveloped in a yellow flame. If M. Fouqué is right in this respect, it is certain that under favourable circumstances volcanic eruptions may be accompanied by flame. To some it may appear extraordinary to question the fact, as the emission of flames is popularly supposed to be one of the chief characteristics of such phenomena; but it is well known that these apparent flames are merely the reflection of the colour of the liquid lava on the scoriæ and lapilli ejected by the volcano, consequently it has been doubted whether flames ever occur during an eruption, and even now it seems more probable that they occur *after* the event than that they accompany it.

Mr. Croll's speculations on cosmical causes of changes of temperature and on the submergence of the northern hemisphere during the Glacial Period have continued under discussion; but the nature of the controversy has somewhat changed, and the medium is now the high-class 'Philosophical Magazine.' The state of the case previous to this discussion may be thus stated:—Post-pliocene marine shells of an Arctic character have been found in England at various heights up to 2,300 feet above the sea-level, and this has ordinarily been considered a proof of submergence to that extent during the Glacial Period; but it has been thought a little extravagant by some geologists to suppose that the land could have been really upheaved so many hundred feet since so recent a date. Mr.

Croll's notion of an ice-cap is one of the ingeniously devised loopholes of escape, which command admiration and deserve success. They obtain the first in abundance, the second in a very slight degree.

The March number of the 'Philosophical Magazine' contained a very elaborate mathematical paper by Mr. Heath, in which he showed that if Mr. Croll's theory "cannot explain elevations or depressions of 1,000 feet, it does teach us there is an agency at work in nature, which had perhaps been overlooked, which must be borne in mind in all speculations where tens of feet are material." We are very glad that Mr. Croll can be said to have done so much service incidentally. In the April number, however, Mr. Croll makes an onslaught on Mr. Heath, restates his theory of an ice-cap, and recalls one or two recantations he had previously made. His paper is followed by a note by Professor W. Thomson, who gives a formula for the calculation of the depression caused by the flow of water to the pole in consequence of the ice-cap altering the centre of gravity.

In the May number of the same periodical Mr. Croll was vigorously attacked by Mr. J. Carrick Moore and Professor Haughton; two assailants of undoubted power, both mathematicians and both geologists—a rare combination. It is quite obvious that the ice which Mr. Croll supposes to have "capped" the North Pole during the Glacial Period must have been derived either entirely from that now existing round the South Pole, or more or less from the water of the present seas. Mr. Carrick Moore assumes, in the first place, that the ice was obtained at the expense of the sea, and shows that an ice-cap, as supposed by Mr. Croll, of 7,000 feet thickness at the pole, would, on this view, cause at lat. 60°, a *depression* of the sea level, not an elevation, to the extent of 833 feet, in consequence of the drain of sea-water exceeding the elevation caused by the attraction of the ice-cap to that extent. Secondly, he proves that if the ice which formerly existed in the northern hemisphere had been derived from the southern, and has now returned there, an ice-cap of a uniform thickness of 2,000 feet over the Antarctic regions, which is certainly an exaggerated estimate of the existing ice, would not supply one-twentieth part of that required to cause a submersion of the land at lat. 60° to the extent of 2,300 feet. Finally, Mr. Carrick Moore observes that, "as the quantity of ice to be supplied by the melting of that at the south pole is so greatly disproportionate to its object, it is unnecessary to discuss what appears to me to have been too lightly assumed—*viz.* that when one pole is under glacial conditions, the opposite will be entirely free from ice."

With respect to Mr. Croll's notion of the eccentricity of the earth's orbit being connected with changes of climate, the Rev.

Professor Haughton remarks that the law received by astronomers is—"That the quantity of heat received per annum from the sun varies inversely as the minor axis of the orbit," that is to say, the heat *increases* with the eccentricity. Mr. Croll's view* was based on a contrary opinion—namely, that the greater the eccentricity the colder the climate. In point of fact, however, he has not only to prove that astronomers are wrong, but also that the difference in temperature owing to the eccentricity of the orbit is sufficiently great to be the determining cause of a Glacial Period.

It is satisfactory to learn that the conclusions of mathematicians respecting the ice-cap theory correspond with those arrived at by a study of facts. Indeed, Mr. Croll has never yet, we believe, attempted to show that the known phenomena of the Glacial Period square with his theories; and unless he can do that, they would not advance us a step, no matter how beautifully symmetrical or mathematically exact they might be. At present we are merely discussing whether they are extraneously possible; their intrinsic probability is quite another question.

Mr. John Evans, of flint implement celebrity, has lately propounded before the Royal Society another theory of the cause of supposed changes in the earth's axis of rotation. He takes the case of a sphere consisting of a mass of viscid or fluid matter, surrounded by a crust of inconsiderable thickness, and in a condition of revolution about a given axis. He then supposes the equilibrium to be disturbed by the protrusion of a portion of the crust somewhere between one of the poles of the sphere and its equator. The result would be, as Mr. Evans states, that the greater centrifugal force possessed by this protruded portion would tend to bring it towards the equator, and thus alter the axis of rotation of the external crust, which would adjust itself about the internal plastic and still spherical mass within. The rotation of the sphere and this excess of centrifugal force possessed by the protruded portion would cause the latter to describe a spiral, as it were, of gradually increasing dimensions, until at last it became in the line of the equator of the sphere, and described a circle, when the axis of rotation would again become fixed until some fresh cause of disturbance produced a repetition of the process. In the same manner Mr. Evans supposes the upheaval of large mountain-masses to have operated on the earth's axis of rotation, the only distinction he draws being that, from the spheroidicity of its figure, there would be more difficulty in the crust adjusting itself over the fluid nucleus. This theory looks very plausible, but if we inquire a little further into the case of the supposed sphere, we shall get an indication of the kind of difficulty it fails to meet when applied to the earth. Imagine a second mass to be protruded after the first shall have arrived at the equator. Before we had to deal with a sphere having no tendency to revolve on one particular axis more than on another; but now there is resistance to be overcome—a resistance intensified by the rotatory motion of the sphere. So, in the case of the oblately spheroidal earth, for a mountain-mass to affect the axis of rotation it must possess a centrifugal force sufficient to overcome the resistance presented by that of the greater protrusion of the earth at the equator, that protrusion being equal to a belt 6½ miles thick at the equator.

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* 'Phil. Mag.,' Jan., 1866.

For some months past geologists have been awaiting with curiosity the publication of the details of an alleged discovery of Bracklesham fossils in beds beneath the Landénien inférieur (Thanet sands) of Belgium. It was felt that if this discovery were really such as it was represented to be, the "Colony" principle must be admitted as an essential element of uncertainty in the determination of the age of a stratum from the evidence of its fossils. Now that MM. Cornet and Briart's paper has been published,* we are in a position to judge of the value of the evidence on which this asserted discovery rests. It appears that a well-section at Obourg, near Mons, revealed sandy beds underlain by limestones, and that these limestones yielded twenty-two species of Bracklesham (Calcaire Grossier) fossils, with about 120 others, mostly new. The sandy beds are considered to be identical with those near Angres and Tournay, which yield *Pholadomya Koninckii*, and are therefore of Landenian age. The proofs of this identity rest partly on a certain amount of lithological correspondence, and partly on sections which seem to prove the uninterrupted continuity of the strata from one locality to the other. But it does not appear that *Pholadomya Koninckii* has yet been obtained from the same section as the Bracklesham fossils. After an endeavour to weigh this evidence impartially and without prejudice, it appears to us that the following is a fair conclusion:—The evidence would be sufficient to establish, until disproved, the position assigned to these fossils by MM. Cornet and Briart, if no violation of previously received geological principles were involved; but, under existing circumstances, this Tertiary "colony" cannot be considered authentic until *Pholadomya Koninckii*, or some equally conclusive fossil, has been found in direct superposition to the Bracklesham shells. Even then the case would seem to be as good for an extension of the range of *Pholadomya Koninckii* as for the "Calcaire Grossier" colony.

The 'Geological Magazine' for the past three months contains so many interesting papers, that our space will not allow us to do justice to them all. In the March number, Mr. S. V. Wood, jun., concludes his memoir on the structure of the Thames Valley. His conclusions are rather heterodox, and could only be understood after a careful perusal of the paper. The most remarkable inference is that the south side of the Thames Valley was subjected to violent convulsions after the deposition of the brick-earth deposits, and the author gives sections showing several faults of very recent date. He also states that in the present Thames Valley there is "nothing analogous to terrace-formation, or to the modification of an estuary by the successive elevation of the land and cutting down of its bed, until the estuary has become a river." He considers the brick-earth deposits to be of three different ages, and the "upheaval of portions of the original valley, the dislocation of its deposits, and the extensive denudation of the uppermost of them," &c., to have taken place after the deposition of the newest of the three. These and many other conclusions are contained in a paper of about thirteen pages, and if Mr. Wood finds that geologists do not accept them, he ought not to be surprised. It would require all those thirteen pages to prove conclusively one of his inferences—*e.g.* that the brick-earths of the Thames Valley are of three distinct ages. There is hardly a fragment of evidence, whether palæontological, strategraphical, or lithological, given in support of a single statement; and it really appears as if the author considered matters of fact too trifling for publication. We recommend Mr. Wood to expand his thirteen pages into a couple of hundred, and give in full the evidence on which his conclusions rest.

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* "Note sur la découverte dans le Hainaut, en dessous des sables rapportés par Dumont au Système Landénien d'un Calcaire grossier avec faune Tertiaire." Par MM. F. L. Cornet et A. Briart. 'Bull. Acad. Roy., Belgique,' 2^{me} série, vol. xx., nº 11.

Professor Phillips describes a new species of *Libellula* from the Stonesfield slate, and starts the question whether the Oolitic insects "manifest any special affinity with congeneric forms now visible in Australia, as do the Cycads, *Waldheimia*, *Trigonia*, *Cucullæa*, and *Phascolotheria*, which are their companions in the deposits of Stonesfield, with the plants, shells, and mammals of that old-fashioned corner of the earth." This is a captivating inquiry for an entomologist, and we hope it will be taken up by a competent authority.

Mr. E. C. H. Day gives a paper "On an Ancient Beach and a submerged Forest near Wissant," and another "On a Raised Beach and other recent formations near Weston-super-Mare." In the first paper Mr. Day asks, "Why has Wissant ceased to be a Port?" and he suggests that it is not because "the *growth* of the sand-dunes had obliterated its harbour," but because of the harbour having been silted up, the shoal which formerly acted as a natural breakwater having been gradually destroyed. The description of the raised beach is also interesting in connection with the questions recently discussed by Mr. Prestwich in describing the neighbouring beach of Sangatte.

In the April number, Captain Hutton gives an interesting sketch of the geology of Malta, and Professor Rupert Jones adds some notes on the fossils from each of the strata described. The Rev. P. B. Brodie contributes a paper "On a Deposit of Phosphatic Nodules in the Lower Greensand at Sandy, Bedfordshire." Mr. Mackintosh supplements his paper, "The Sea *versus* Rain and Frost," by one entitled "The Sea against Rivers; or, the Origin of Valleys." Mr. Wyatt Edgell describes a new *Lichas* from the Llandilo Flags; and Professor Church gives a note on Chinese figure-stones. We should have been tempted to discuss Mr. Mackintosh's paper had it not been ably met by a paper in the May number from the pen of a very eminent geologist, Mr. Poulett Scrope, M.P. The author's arguments are chiefly drawn from the Auvergne district, and he conclusively shows how great has been the influence of "Rain and Rivers" in scooping out valleys in that district. He also adds that they have done their work "wherever land lay exposed to their influence above the protecting surface of the great waters." But Mr. Scrope is not a red-hot partisan, as will be seen by his concluding sentence: "The object of this paper is simply to suggest that the two denuding agencies have been always at work upon the surface of the earth, and that there is ample reason to consider the one to have produced effects quite as considerable as the other."

Professor Owen gives, in the same number, a description of a new Mammal (*Stylodon pusillus*) "nearly allied to *Spalacotherium tricuspidens* (Ow.), and from the same formation and locality, *viz.* the Marly bed, Upper Oolite, Purbeck, Dorsetshire." The locality and horizon appear to be rather indefinite, and would scarcely be understood but for the reference to *Spalacotherium*. Mr. H. M. Jenkins notes the occurrence of *Trigonia Lamarckii* (a recent species) in the Tertiary deposits of Victoria, which he considers of importance because of its bringing the Oolitic and recent types of the genus into such close proximity. Mr. H. Woodward records the occurrence of *Ceratiocaris* in the Wenlock Limestone, and Mr. T. M'Kenny Hughes adds a "Note on the Silurian rocks of Casterton Low Fell, Kirkby Lonsdale, Westmoreland," one of the localities which yielded the specimens of *Ceratiocaris* described by Mr. Woodward. There is also a paper "On the Junction of the Chalk with the Tertiary beds in East Kent;" but, like many of its associates, we must pass it by without further notice.

PROCEEDINGS OF THE GEOLOGICAL SOCIETY.

A very bulky number of the Society's journal contains this quarter a very insignificant instalment of the Society's proceedings, more than half of it being taken up with the Annual Report and the

President's address. The report represents the society to be in a very flourishing condition, both numerically and "financially." The address contains notices of a large number of the more important geological works that were published during 1865; but as most of them are by this time familiar to our readers, we shall not stop to discuss them. We cannot, however, refrain from noticing an opinion, which is very heterodox, but which, nevertheless, may one day turn out to be valuable, perhaps premonitory of a great discovery. Mr. Hamilton (the president of the society) thinks "that the time is come when it is desirable to investigate this question—Whether the theory of central incandescent heat is tenable?" So far so good, except that it seems difficult to imagine heat itself as "incandescent;" but the sequel is extraordinary—namely, "Whether the plastic condition of the earth, to which its oblate spheroidal form has been attributed, be not owing to an aqueous rather than to an igneous origin?" Mr. Hamilton further enunciates the following problem as a corollary:—"Whether the formation of the earth may not have commenced with a central nucleus consisting of an aqueous paste, gradually increasing in size as matter was deposited around it from the circumambient fluids and gases which filled the solar space before solid matter was aggregated round those spots which now form the planets in our solar system?" Mr. Hamilton suggests these and other questions for the consideration of the society; but the inquiry is purely one for physicists and astronomers.

Two out of the three papers contained in the same number of the 'Quarterly Journal' are deserving of notice. In the first, "On the Western Limit of the Rhætic Beds in South Wales, and on the Position of the Sutton Stone," Mr. E. B. Tawney shows that the Rhætic beds are continued as far westward as near Pyle, west of Bridgend; and that the Sutton stone and some beds above (named by him the Southerndown series), which occur at and near Dunraven Castle, Sutton, &c., do not belong to the Lias but to the Rhætic beds. He also expresses the opinion that the Sutton beds are slightly anterior in time to the *Avicula-contorta* series, so that his discovery of *Ammonites* in them is of somec onsiderable importance. In a note to this paper, Dr. Duncan gives more decided evidence respecting the age of the Sutton beds as the result of an examination of the corals. He states that these corals "in the Alpine Trias would be deemed St. Cassian," and the only consideration which induces him to make any reservation about the St. Cassian age of the Sutton beds, is the defective nature of our information respecting the range of the St. Cassian corals, and their relation to those of the Dachstein and Kössen strata. If further researches confirm the high antiquity here suggested as belonging to the Sutton beds, a zone of life will have been discovered in

England by Mr. Tawney, which has hitherto been supposed to be confined in Europe to the Triassic districts of the Alps.

The only other paper we shall notice is that by Dr. J. W. Dawson, "On the Conditions of the Deposition of Coal, more especially as illustrated by the Coal-formation of Nova Scotia and New Brunswick." The title of this paper is very unfortunate and very deceptive, for so far from the author believing in the "deposition" of coal, he contends that the occurrence of *Stigmaria* under nearly every coal-bed proves beyond question that the material of the coal was accumulated by a growth *in situ*, and this reasoning has always obtained the full consideration to which it is entitled. Dr. Dawson's paper treats of so many other points that in a chronicle of this nature it is impossible even to enumerate them. Amongst these is the contrast afforded by the characters of the intervening strata to what is yielded by those of the coal and the underclays—namely, while the latter prove the growth of the coal *in situ*, the former prove the abundant transport of mud and sand by water; that is to say, the conditions employed are such as prevail in the swampy deltas of great rivers. One subject touching on the philosophy of geology is discussed by Dr. Dawson with great effect—namely, the bearing of the lithological characters of the successive beds in each great formation on the interpretation of the sequence of events which occurred during their deposition, and his opinion is, that we must regard each of the great formations as the evidence of a period "presenting during its whole continuance the diversified conditions of land and water, with their appropriate inhabitants," and "as forming a geological cycle, in which such conditions were to a certain extent successive." In conclusion, we may state that this is a capital paper, philosophically conceived and carefully executed.

VIII.—MINING, MINERALOGY, AND METALLURGY.

Mining.

Tin and copper mining were never in a less profitable state than they are at present in this country. There are scarcely ten mines in the United Kingdom, producing those metals, which are not at the present time working at a loss. The aspect around is gloomy; nowhere does there appear a bright spot to kindle hope.

Never during any one year has there been a larger quantity of tin ore raised from the mines of Cornwall and Devonshire than during 1865. This rash process continues, and the tin ore sales of last month were larger than in any previous month, with one solitary exception. The consequences of the American civil war led to an extinction of the tin-plate trade, and thus greatly reduced the consumption of tin. This produced naturally a reduction of price. Upon this the Cornish mines,—for the purpose of maintaining their dividends, preventing calls, and keeping the miners, who have long shown a disposition to emigrate,—have been made to yield a quantity of tin ore, much in excess of the requirements of the manufacturer. At the same time, tin, in unusually large quantities, has been thrown into the English market by the Dutch speculators. Banca and Billiton tin have, from their having improved in quality, and being cheaper, taken the place of English tin, in many of our large works. At the present time the price of tin ore is not sufficient to pay the expenses of producing it, yet the mines continue to press their ores upon the smelters, in the face of a serious present loss and a too evident future failure, which must be ruinous. A monthly metal circular now before us says:—"We have received about 2,000 slabs of Straits tin from America, and there is little chance of any demand for export hence to that country; while, owing to the stagnation of the tin-plate trade, consumption of tin must have fallen off, and will continue to do so for the next two months." The quantity of tin here and in Holland on the 31st of May was as follows, compared with the three preceding years:—

	Tons.
1866	10,457
1865	10,000
1864	8,690
1863	6,815

In the face of the continental disturbance which threatens, we cannot dare to hope for a better report in our next.

The copper mines suffer from other causes than those influencing the tin mines. The present price of English tough cake copper is 19*l.* per ton below the average of the last sixteen years. The influences through which this state of things has been brought about are not clear. It has been referred to the failure of the usual demand for copper in India; but this appears quite insufficient to create this extreme depression. Our supplies of copper from Chili have fallen off in consequence of the war with Spain, and for some time to come we cannot expect any large quantity of copper from that country. The deficiency will certainly not be made up by any increased supplies from other parts of the world. We may, consequently, hope, in a little time, to see our English copper mines becoming more profitable than they have been for some time past.

	Tons.
The tin-mines of Cornwall and Devonshire produced, in 1865, of Black Tin (Tin Ore)	15,686
The production in 1864 having been	15,211
The quantity of Copper Ore produced from the mines of Cornwall and Devonshire in 1865 was	159,406
The production in 1864 being	163,336
The Swansea sales of Irish, Welsh, and Foreign Copper Ores were, in 1865	25,217
Against, in 1864	32,413

Our notices of mining operations in other countries must necessarily be brief. A considerable degree of excitement has been created in relation to mining in California, and not a little, especially in America, in connection with the development of the wonderful Lake Superior district.

By the courtesy of the proprietors, we have been favoured with copies of the 'American Journal of Mining,' published in New York. This new periodical, embracing "Milling, Oil-boring, Geology, Mineralogy, Metallurgy," &c., has a sufficiently expanded field for its labours. Within the United States territory, nearly every metalliferous and earthy mineral has been found. The extent of the American coal-fields is vast, and roads and railways are rapidly opening out districts from which the supply of fuel can be abundantly obtained. A new industry has been created in the oil regions, and the rapidity with which the iron manufacture of the United States is expanding, shows that such a journal as that now before us, if conducted with strict honesty of purpose, must become important, equally to the miner, the metallurgist, the manufacturer, and the public. The 'American Journal of Mining' evidently takes the 'Mining Journal' of this country as the example it would follow. Reports on mines and mining, correspondence on these, on metallurgy and mineral manufactures, with notices of these sciences which bear upon any of those industries, and a very extensive share-list, form the bulk of the papers yet issued.

Amongst the original papers, those on "Petroleum," by Professor Francis E. Engelhardt, promise to be as valuable and instructive, as they are interesting. From the "Mining Statistics," by Dr. R. P. Stevens, we abstract the following particulars relative to several branches of mining and metallurgy:—

The rapid increase of mining and metallurgical works in America are a striking proof of the rapid development of those important industries in that great continent.

We find it stated in United States' official documents that there are now 157 mining establishments engaged in raising iron ore, employing 3,177 men. There are 97 bloomaries, 286 furnaces, 256 rolling mills, 16 mills for drawing iron wire, 17 car-wheel manufactories, 1,412 establishments for castings, 19 for locomotives, 74 for sewing-machines, 239 for arms, 443 for hardware, 382 for steel, 99 for nails, 134 for scythes, and 14 for printing-presses.

Copper.—There are 42 mining establishments in Michigan, New Mexico, Tennessee, and North Carolina, producing 499,534 tons of ore.

Coal.—In round numbers the production is stated at 15,000,000 tons. In our last, we gave it from a strictly reliable source as 14,593,659 tons. The collieries employ 36,469 workmen.

Lead and Silver.—Lead mining and smelting are stated to have produced about 12,000,000 dollars, and silver about 5,000,000 dollars.

Gold.—7,202 mining establishments are reported. These are situated in California, New Mexico, Oregon, North Carolina, Georgia, Virginia, and South Carolina, placing the States in the order of their productiveness. The gold they produced is given as 47,566,000 dollars.

Those who are interested in the mode of occurrence of petroleum may obtain a large amount of information by referring to the 'Proceedings of the American Philosophical Society for May, 1865,' in which will be found a very satisfactory description of the petroleum deposits in the eastern coal-field of Kentucky, by Mr. T. P. Lesley.

The general condition of an "Oil" country is thus described. Mr. Lesley is writing especially of the neighbourhood of Paint Lick Creek, Kentucky. "Petroleum is the mineral that excites most interest at present in all this region, and the show which it makes upon the surface is extraordinary. It issues in numerous places from the base of the cliffs which form the walls of the cañons, through which flow the main Paint and its many branches. It saturates the slopes and banks of loose sand. It flows off, when the sand is stirred with a stick, as a shining scum upon the surface of the stream. It has been caught against booms and barrelled for sale. It unites, also, with the sweepings from the sub-conglomerate ore and coal shales, and forms slimy ore-bogs and muck-heaps, where the base of the conglomerate is at any greater height than usual above the water-bed, and the slope from it is therefore longer than usual. Such is the case at the Old Oil Springs, on the north line of the May and Ross Survey, where it crosses the Little or South Fork of Paint; and again 200 yards lower down, at Pendleton's Oil Springs.

"A black reservoir of tar-like oil here occupies the centre of a sloping bog, and is kept always full from a spring at its upper limit, near the top of the slope and the foot of the cliffs, about twenty feet above the level of the stream."

A remarkable extension of shale mining for the production of petroleum is also taking place in this country. More than 100 retorts have lately been set to work in North Staffordshire. In Derbyshire and in Yorkshire many works are rapidly progressing towards completion, for the distillation of oil. All the old works in Flintshire are actively distilling cannel coal and shale; and in addition to the established works in Scotland, using the Torbanehill mineral, several others are starting. The consequent enormous production of "coal oil" in this country, added to the immense importation of petroleum from America, must lead to a great reduction of price, and an extension of its use for illuminating and lubricating purposes.

The coal production of this country, as we learn, shows but a slight increase in 1865 over the production of 1864. A considerable excitement has arisen on the "Coal Question" since Mr. J. S. Mill drew attention to Mr. Stanley Jevons' book in the House of Commons. In this journal Mr. E. Hull has already dealt with the subject.

On the 12th of June Mr. Hussey Vivian moved, in the House of Commons, "that an humble address be presented to Her Majesty, praying that she will be graciously pleased to issue a Royal commission to investigate the probable quantity of coal contained in the coal-fields of Great Britain, and to report on the quantity of such coal which may be reasonably expected to be available for use; whether it is probable that coal exists at workable depths under the Permian, New Red Sandstone, and other superincumbent strata, and whether they would recommend that bore-holes should be sunk in any and what localities; to ascertain and report on the quantity of coal at present consumed in the various branches of manufacture, for steam navigation and for domestic purposes, as well as the quantity exported, and how far and to what extent such consumption and export may be expected to increase; how far the increase of population must necessarily accord with the increased consumption of coal, and the relations which one is likely to bear to the other; and whether there is reason to believe that coal is wasted either by bad workmanship, or by carelessness, or neglect of proper appliances for its economical consumption, and whether they would recommend legislation, with a view to avoid such waste."

After an interesting debate on this important subject, in which all agreed that an inquiry was necessary, Sir George Grey said, "The Government thought it desirable to associate with the chief members of the Geological Survey Department, men of great practical knowledge and experience in the working of mines and manufacturing operations, with a view to a searching and impartial inquiry, in the result of which the country might place confidence. They thought that the commission should consist of a mixed body, and include men of the highest scientific attainments, among whom he hoped Sir R. Murchison would allow himself to be placed. Upon that understanding the Government were prepared to agree to the motion."

We may, therefore, hope that the "Coal Question" will receive a satisfactory solution.

MINERALOGY.

The most important contribution to this science during the quarter has been Bernhard von Cotta's 'Treatise on Lithology'* in its English form, for which we are indebted to Philip Henry Lawrence; the translation, however, being revised by the author. The original work of Cotta is well known. Opinions vary widely as to its merits, but it has passed through two German editions, and a third is in preparation.

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* 'Rocks Classified and Described: a Treatise on Lithology.' By Bernhard von Cotta. An English edition, by Philip Henry Lawrence. Longman, Green, & Co.

This alone speaks loudly in favour of a work which is purely scientific, and may be accepted as the best possible testimony to its general merits. Professor Cotta informs us—"This English edition may be considered as the third edition of my original work, although, if the appearance of a third German edition should be delayed for some time longer, there will doubtless be new matter and fresh alterations to be introduced; for science marches with uninterrupted steps towards new fields of discovery, and every year alters its aspect. In a system of lithology, however, most of the names which are in use will probably remain, and one chief object of this book is to define these so as to render intelligible the ideas which each name should convey, and both author and translator are actuated by the desire and ambition of arriving, as far as may be possible, at a common ground for all nations in respect of the important matter of rock nomenclature."

A careful examination of this important work must be reserved, and will probably be presented to our readers on a future occasion; it is sufficient now that we have directed attention to the first appearance in the English language of a comprehensive treatise on Lithology.

The following mineralogical works have appeared during the quarter:—'Die Minerale der Schweiz,' von Dr. Adolf Kenngott. Leipzig. 1866.—'Vorlesungen über Mineralogie,' von Kokscharow. 1 Band. St. Petersburg. 1865. (Received by us not until March, 1866.)—'A Catalogue of Siberian Topazes,' by Kokscharow. St. Petersburg. 1866. (Written in the Russian language.)

Analyses of *Rahtite*, of *Marcylite*, and of *Moronolite*, by Mr. S. W. Tyler, are given in 'Silliman's Journal,' by Professor Charles U. Shepard.* *Rahtite* was distinguished as a new species by Mr. Tyler in 1861, during a survey of the Ducktown copper-mines, Tennessee. It is found associated with melaconite, chalcopyrite, and Redruthite, in the decomposed portions of the great copper lodes of these mines. The colour of the mineral is a dark lead-grey, with a tinge of blue, not unlike some of the ores of antimony. Its structure is massive, though at first inspection it seems highly crystalline; but this deceptive appearance arises from its being traversed in all directions by slender prismatic cavities, imparted to it by some unknown mineral which has wholly disappeared. The walls of these cells are polished and bright.

The analysis of Rahtite, which is so named after Captain Raht, the manager of the principal Ducktown mines, gives its composition as:—

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* 'The American Journal of Science and Art,' No. 122.

Sulphur	33·36
Copper	14·00
Iron	6·18
Zinc	47·86
	101·40

Marcylite, a mineral already described in Shepard's 'Mineralogy,' but not hitherto obtained in a pure state, is, according to Mr. Tyler's analysis:—

Sulphide of Copper	47·70
Sulphide of Iron	2·86
Oxide of Copper	39·70
Sulphate of Copper	2·13
Water	9·00
	101·39

The name given to this copper ore is unfortunately like Marceline—one of the oxides of manganese, for which, by its name, it may be mistaken.

Moronolite appears to be nearly identical with Gelbeisenerz and Jarosite, a potash-copperas,* the only peculiarity being that while the two last have each but one of the alkalies, they are both present in Moronolite.

Professor Shepard † calls attention to a mineral found in the old workings of the Southampton lead mine in Massachusetts, which proves to be *Scheeletine*, a tungstate of lead. He also notices the discovery of Uwarowite,—a lime-chrome-garnet,—from Wood's chrome-mine, Texas, Pennsylvania.

Professor E. J. Chapman, of Toronto, writes of the discovery of native lead in some mines on the north-west shores of Lake Superior. Native lead has been found by the late Captain Stephen Eddy, in the mines of the Duke of Devonshire, in Yorkshire.

A new arseniate of zinc, called after M. Adam, *Adamite* ‡—the crystal, first examined by M. Friedel—having been found in the cabinet of that mineralogist,—has been brought to the notice of the Academy of Sciences of Paris. The specimen was from Chili, and was mixed in a mass of native silver with Limonite. Chemical analysis showed it to consist of:—

Arsenic Acid	59·95
Oxide of Zinc	34·32
Protoxide of Iron	1·48
Oxide of Manganese	a trace.
Water	4 55
	100·30

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* See 'Bristow's Glossary of Mineralogy.'

† 'American Journal of Science and Art,' No. 122.

‡ 'Comptes Rendus,' No. 12, p. 692.

These numbers accord with the formula $As\,Zn^2\,H\,\theta^3$; while, at the same time, the crystalline form shows the most complete isomorphism to exist between this new substance and Olivenite and Libethenite.

Sir David Brewster brought before the Royal Society of Edinburgh a very fine specimen of fossil amber discovered in the kingdom of Ava. Mr. T. C. Archer also called the attention of the Society to a new bituminous substance imported into Liverpool from Brazil. This bituminous shale was submitted to the examination of Dr. Edwards, who declared it to contain a larger quantity of oil than the Torbanehill mineral. Some specimens of bituminous schists were exhibited in the Brazilian collection in 1862; from one of the localities then named, this specimen is supposed to be derived.

In a letter read by M. St. Claire-Deville, at a meeting of the Academy of Sciences, M. Wöhler described a new mineral from Borneo. This mineral, for which the name of *Laurite* is proposed, is a sesquisulphide of Ruthenium combined or mixed with sulphide of Osmium. Laurite is found in the form of small globules having slight appearance of crystallization. In colour and brilliancy it resembles crystallized oligist. An analysis of Laurite gave:—

Ruthenium	65·18
Osmium	3·03
Sulphur	31·79

This mineral—which appears to be the first example found of a natural sulphide of the platinum group—is not attacked by either nitro-muriatic acid, or by bisulphate of potash at a red heat. It fuses, however, with hydrate of potash and nitre, forming a brown mass, which gives a fine orange-coloured solution.

M. Berthollet has recently published a new hypothesis on the origin of carburets and the combustible minerals.* Although those combustible minerals, which obviously result from the transformation of organic matter, admit of explanation, there are others which are not so produced, as the carburets observed in the products of volcanic eruptions, and such as have been detected by M. Daubrée in meteorites, which require some other explanation. M. Berthollet supposes carbonic acid, penetrating the crust of the earth, is brought in contact with the alkaline metals at a high temperature, that thus acetyl is first formed, which undergoes a series of reactions, giving rise to the almost infinite series of hydro-carbon compounds. We must refer our readers to the original communication and to M. Berthollet's previous experiments.

M. Pisani in one of the last *séances* of the Académie des Sciences presented a note upon a new mineral, which had been especially examined by M. Adam. It is an arseniate of copper, but differing from the arseniates which had been analyzed by Bournon, Haüy, and Beudant, in containing a notable quantity of oxide of iron. Amongst the analyses which have been made of *Aphanese* or *Clinoclase* as it was supposed, was one by Chenevix, which gave arsenic acid 33·5, oxide of copper 22·5, oxide of iron 27·5, water and sand 15·0. This was suspected to be an error until Mr. Adam analyzed a specimen for M. Pisani, and proved it to be a species different from the other arseniates of copper. His analysis was:—

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* See 'L'Institut,' May 16, 1866.

Arsenic Acid	32·20
Phosphoric Acid	2·30
Oxide of Copper	31·70
Oxide of Iron	25·10
Lime	0·34
Water	8·66
	100·30

To this mineral, which so nearly approaches the arseniate of copper analyzed by Chenevix, it is proposed to give the name of *Chenevixite.* It is found in little compact masses in the quartzose rocks of Cornwall. They are usually so interpenetrated with the gangue, that it has been impossible to separate the one completely from the other; thus the density which has been obtained is only approximate, namely, 3·93; its hardness being 4·8. It is opaque, with a conchoidal fracture, and of a dull-green colour passing to yellow.*

A peculiar example of a physical change in a diamond has recently been brought under the notice of the Académie des Sciences of Paris. M. Frémy exhibited at the meeting on the 7th of May a diamond weighing more than sixty grains, which at the ordinary temperature is lightly shaded yellow, but which, when submitted to the action of an elevated temperature, assumed a rose tint, which it preserved for several days, returning gradually to its normal yellow tint. This diamond being rose-coloured at one *séance*, will, if preserved in the cabinet of the Institute until the next *séance*, again exhibit its original yellow colour. The ordinary price of a diamond of this weight would be about 60,000 francs; with the rose-colour, if this was permanent, the value would be at least tripled. We believe this is the first example of a diamond of variable colour.

Professor J. D. Whitney† has been examining Clear Lake in California and its neighbourhood. This lake is sixty-five miles north-west of Suisun Bay, and is about twenty-five miles long. On the south-west side of a narrow arm of this lake is a small lake about two-and-a-half miles in circumference, known as the "Borax Lake." From the waters of this lake, evidently of volcanic origin, there can be extracted, without much trouble, a large quantity of borax in the condition of nearly absolute purity. The value of this discovery is great indeed. We have seen natural crystals of borax from two to three inches in length brought from this remarkable region. We understand that an English chemist is now engaged in investigating the matter, and there is no doubt but in a short time, by either English industry or American energy, this new source of borax will be brought into active rivalry with the lagoons of Tuscany. Indeed, a "California Borax Company" is already formed.

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* 'Les Mondes,' April 12, 1866. 'Comptes Rendus,' No. 12, p. 690.

† 'Geological Survey of California,' by J. D. Whitney, State Geologist.

A new source of the metal *Indium* has been found by Dr. Kachler in the zinc blende of Schoenfeld, near Schloggenwald, in which mineral it is associated with tin and other metals in such proportion that some grains of it can be separated. The blende is roasted, dissolved in sulphuric acid, and the solution treated with metallic zinc, the Indium is then precipitated with the other metals, from which it can be ultimately separated.

M. Henry Soliel has presented to the Académie des Sciences of Paris a memoir "Upon the Direction of the Optical Axis in Rock Crystals." This is a very elaborate examination of this optical question, to which M. Henry Soliel appears to have found a very perfect solution. This memoir will appear in the 'Comptes Rendus' of the Academy.

Leuchtenbergite is the name of a mineral, to which the Duke Nicholas of Leuchtenberg has recently drawn the attention of the Academy of Sciences of St. Petersburg, with a view to remove the uncertainty which surrounded it. Breithaupt considered it as an altered *Chlorite;* Komonen found but 8·62 per cent. of water; Cloizeaux regarded this mineral as a variety of *Pennine;* while Nauman regarded it as a variety of *Clinochlore.*

The Leuchtenbergite is found near Slatoust and in the mountains of Chichime in the Ural. It is a talc-like mineral, with a hardness of 2·5 and a density of 2·61. The analysis of the mineral gives:—

Silica	30·60
Oxide of Iron	2·02
Lime Magnesia	34·41
Alumina	19·63
Water	12·76
	99·42

This is nearly the composition of Clinochlore; but its physical characteristics induce the Duke of Leuchtenberg to regard it as a distinct variety, appertaining to the group of Chlorites.

Dr. Heddle communicates to the 'Philosophical Magazine'[*] the following notice of a British variety of Wulfenite:—

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[*] 'Philosophical Magazine,' April, 1866.

"Greg and Lettsom doubt whether or not Wulfenite may rank as a British species. In Thomson's 'Mineralogy,' vol. i., p. 565, we find the following remarks on a specimen (a single specimen) in the possession of the Stockholm Academy:—'It was ticketed *lead spar*, from Mendip, near Churchill, in Somersetshire; it was chiefly carbonate of lead, but it contained two portions of a yellower colour than the rest, which attracted the particular attention of Berzelius.[*] One of them being examined by the blowpipe proved to be molybdate of lead; the other portion was an oxychloride of lead.'

"This, so far as I know, is the only published record of the occurrence of this substance in Britain. Lately a new pit was sunk for some thirty fathoms at the 'South of Scotland Mines,' at Lackentyre, near Gateshead, in Kirkcudbrightshire, and amongst many interesting minerals brought me thence by Mr. James Russel, of Airdrie, there was a single specimen of the molybdate. The associated minerals are galena, carbonate and phosphate of lead, and cupreous calamine; the molybdate occurs in well-pronounced and unusually brilliantly polished crystals of about $\frac{1}{8}$ inch in size; the crystals are thin, transparent, and bright yellow. The pit in which this specimen was found proved unproductive, and has been abandoned; there is thus little hope of others being obtained."

Our Mineralogical notices would not be complete without a record of the following papers:—"Über den Titanit im Syenit des Plauen'schen Grundes," von P. Grosh.[†]—"Über der Natur der Silicate," von Dr. Mohr.[‡]—"Neubildung von Schwefelkupfer in vergelbtem Papier alter Bücher," Kerner.[§]—"Mineralogical Correspondence."[‖]—"Kondroarsenit, ein neues Mineral."[¶]—"Alloklas, ein neues Mineral."[**]—"Über den Klipsteinit, ein neues Mangansilicat," von Prof. Kobell.[††]—"Preisaufgabe aus dem Gebiete der Mineralogie."[‡‡]—"Mineralogische Studien," von Breithaupt.[§§]

M. Daubree has published 'Expériences synthétiques relatives aux Météorites. Rapprochments auxquels ces Expériences conduisent, &c.;"[‖‖] and M. Boussingault writes,[¶¶] "Sur la nitrière de Tacunga, dans l'Etat de l'Equateur."

METALLURGY.

Although there are several patent processes, of more or less merit, which may eventually require a notice from us, these are all at present in the condition of undeveloped schemes. Beyond those, there is an entire absence of any real improvement in any branch of metallurgy to be noticed.

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[*] 'Kong. Vet. Acad. Handl.' 1823, p. 184.

[†] 'Neues Jahrbuch für Mineralogie,' 1 Heft, p. 45.

[‡] Ibid., 2 Heft, p. 181.

[§] Ibid., p. 227.

[‖] Ibid.

[¶] 'Journal für Praktische Chemie,' No. 1, p. 60.

[**] Ibid., No. 2, p. 125.

[††] Ibid., No. 3, p. 180.

[‡‡] 'Oesterreiche Zeitschrift für Berg. und Hüttenwesen,' p. 102.

[§§] 'Berg. und Hutten männische Zeitung.'

[‖‖] 'Comptes Rendus,' No. 5, p. 200; No. 8, p. 369; No. 12, p. 660.

[¶¶] 'Annales de Chemie et Physique,' Mars, p. 358.

M. L. Cailletez has an interesting memoir on the "Dissociation des gaz dans les foyers métallurgiques," in which he confirms the results obtained by M. H. St. Claire-Deville by experiments on a laboratory scale.*

IX. PHYSICS.

Light.—Father Secchi has sent to the Academy of Sciences an account of the spectra of some stars, as recently seen by him in a new spectrometer by Merz, with a prism by Hofmann, of Paris. A drawing of the spectrum of α Orionis accompanied the communication. The spectrum of Sirius is described by the learned author as resembling that of sulphur.

A suggestion, which is likely to be of considerable value to photographers, has been made by Dr. Angus Smith, F.R.S. The cause of the destruction of photographs, apparently by the action of time only, is generally considered to be due in reality to the presence of a minute quantity of hyposulphite of soda remaining in the paper. Hitherto almost the only plan of getting rid of this agent has been long and continuous washing in cold or hot water. Dr. Angus Smith has suggested oxidizing the hyposulphite of soda into sulphate of soda (which is likely to be harmless), by means of dilute peroxide of hydrogen. Peroxide of hydrogen has been little known to chemists, and even now it is seldom obtained in its pure state. It is, however, to be had in a solution, and in a state sufficiently strong for many important purposes in analysis. Oxides, such as in the case of manganese, which will not fall till more highly oxidized, are with advantage treated by it. The lower oxide may remain unobserved in a solution, and in a state of minuteness sufficient to keep it in suspension; but at the moment of contact with the peroxide of hydrogen it blackens and falls.

When the peroxide is poured into a solution of hyposulphite of soda, the change is not observed, as there is no coloured oxide to be formed; but when a salt of barium is afterwards added, it is found that sulphuric acid has taken the place of hyposulphurous. The strength of the solution does not require to be great. That which is sold contains about nine volumes of available oxygen. If diluted a thousand times, a solution is obtained capable of oxidizing hyposulphites. It appears that all the hyposulphurous acid is instantly converted.

Peroxide of hydrogen is in reality an oxide of water; when the oxygen leaves it to do its work nothing but water is left; nothing being added to be washed out.

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* 'Les Mondes,' April 19, 1866.

The peroxide, as sold, contains a little acid (sulphuric); when made alkaline it does not keep so well. If a drop is put upon a photograph it very slowly bleaches; its use in this undiluted state is not recommended. Again, if the peroxide, as sold, is neutralized, the bleaching does not take place, at least in an hour, an ample time. For neutralization soda may be used.

HEAT.—M. Cailletet has continued the experiments of Deville on the dissociation of compound gases at high temperatures.

The author, by peculiar contrivances, drew air from blast furnaces, and submitted it to analysis. The first analysis is of gas taken from the hottest part of a furnace, and rapidly cooled by a stream of water, on the plan of M. St. Claire-Deville. The mixture was composed of—

	I.	II.
Oxygen	15·24	15·75
Hydrogen	1·80	„
Carbonic oxide	2·10	1·30
Carbonic acid	3·00	2·15
Nitrogen	77·86	80·80
	100·00	100·00

These results confirm those of Deville, and show that oxygen does not combine with hydrogen, carbon, or carbonic oxide at very high temperatures. The author afterwards took air from furnaces at lower temperatures, and the results show the gradual disappearance of the oxygen with the abasement of the temperature, and of course the increase of carbonic acid. M. Cailletet concludes that compound gases cannot exist at high temperatures.

A curious fact in relation to the storage of solar heat for future use has been communicated by M. Jeannel to the French Academy of Sciences. Fused acetate of soda, allowed to cool in the open air, crystallizes in prismatic needles at + 58°; allowed to cool, however, in a limited amount of moist air, it does not crystallize even at zero, but becomes a soft translucent mass. If, after having been so cooled, it is exposed freely to dry air, and touched with a dry solid body, it suddenly assumes the ordinary crystalline form of prismatic needles, and rises to the crystallizing point + 58°, or near it. M. Jeannel remarks that this experiment shows how solar heat may be stored up and made to re-appear again at will. It is possible, he says, in our climates to raise acetate of soda under bell-glasses or glass frames to + 59°. The acetate so exposed and cooled, sheltered from the air, does not crystallize, and is always ready to give out the heat again on being touched with a dry solid body.

M. de Vignette Lamotte has sent to the French Academy a long memoir, "On the Preservation of Wines by the Employment of Heat." M. Pasteur, reviving an old suggestion of Appert, proposes to heat wine for a few minutes to 70 or 80 C. The author objects to this, and says it is better to submit the wines for some time to a temperature not exceeding 45 C. He seems to admit, however, that Appert's or Pasteur's plan answers well with the more saccharine and alcoholic wines, like ports and sherries, &c.

Some remarkable results of the exposure of phosphorus to heat have been communicated by M. Hittorf to the 'Annalen der Physik und Chemie.' Schroetter states that red phosphorus returns to the state of ordinary phosphorus at 260° C., but M. Hittorf finds that this change does not take place under a temperature of about 447° C. At a lower temperature red phosphorus may volatilize, and its vapour acquire a high tension without ceasing to belong to the red modification. The transformation of ordinary into red phosphorus may easily be effected by heating in a closed vessel at a temperature above 300° C.

In vaporizing amorphous phosphorus, it does not melt; in this resembling its congener arsenic, which resemblance induced M. Hittorf to endeavour to crystallize this variety of phosphorus, which he believed would take rhomboidal forms like arsenic; his experiments proved him to be right.

Of the numerous attempts made by M. Hittorf, we will cite only that which was successful: it consists in heating red phosphorus and lead in a closed vessel, the lead dissolved the phosphorus, and then deposited it in a crystallized state. The operation was performed in a fusible green glass tube, a quarter filled with ordinary phosphorus, and the rest with lead; the tube was first cleared of air by means of a current of carbonic acid gas, then exhausted, and afterwards sealed. It was now introduced into an iron muffle, and the spaces filled with calcined magnesia, pressed round the whole of the glass tube.

After ten hours' heating, the lead was covered with brilliant flakes of metallic-looking phosphorus, the finest appearing red when held to the light.

No polyhedric form could be recognized in these crystals, but the lead retained some. These were isolated by treating by nitric acid of 1·1, which has no action on phosphorus, while it readily forms nitrate of lead.

The crystalline powder accumulated at the bottom of the vessel was "metallic" phosphorus, which was then in the form of a mass of microscopic rhombohedra, resembling crystals of arsenic. In this state phosphorus is a conductor of electricity; at 15·5° C. its density is 2·34.

M. Hittorf classes the new modification of phosphorus in the same category with red phosphorus, and gives to the two the generic name of metallic phosphorus, which he subdivides into metallic crystallized and metallic amorphous. Commercial amorphous phosphorus is often in the crystalline state.

Microscopists and others who are occasionally engaged in the examination of organic tissues and gelatinous substances, will be glad to know of a method by which these bodies can be dried without the application of heat. A large number of substances, like gum, &c., have, as is well known, the property of agglomerating, upon drying, into amorphous masses, more or less solid and translucent, by which, on the one hand, the original appearance of the freshly made preparation is lost, and, on the other, complete desiccation rendered very difficult. In order to obviate this adhesion of the elementary particles occurring during the drying of such substances under ordinary circumstances, Reischauer has proposed to carry on this operation out of contact with the atmosphere, and by the aid of a suitable ethereal medium.

The apparatus employed for this purpose is, in its simplest form, a well-closed glass vessel filled with ether or a similar liquid, at the bottom of which is placed the chloride of calcium, quicklime, calcined sulphate of copper, &c., intended to absorb the water. A shallow vessel is placed below the surface of the liquid for the reception of the substance to be dried. The *modus operandi* is now a very simple one. The ether continually yielding its water to the chloride of calcium constantly withdraws it in turn from the substance to be dried, until, finally, the latter corresponds in its hygroscopic state with that of the desiccating agent. The thorough wetting in this manner of the constituent particles of the substance to be dried (which, of course, must be insoluble in an ethereal liquid) prevents their sticking together, and the original appearance is retained when dry.

Gum, separated by precipitating the aqueous solution with alcohol, gives an amorphous white mass of very slight adhesiveness, and with no trace of the common glass-like condition. The so-called diastase, or the body obtained by precipitating the extract of malt with alcohol, deprived of water under ether, forms spongy and very light granules. In this state it retains its effect upon starch. The microscopical examination of starch paste dried by this process leaves scarcely a doubt that the starch grains exist in paste in a state only of extraordinary expansion, and not in that of actual solution. Hops give a mass similar to diastase, but, however, no longer capable of producing fermentation. The organs of plants dry rapidly under this treatment, commonly retaining their colour, unless unusually delicate. Taken from the ether, they soon become moist again in the air, and rapidly lose their colour, which by a continuance in the liquid appears remarkably fine.

The behaviour of animal productions under this method of drying is of especial interest. It may be remarked, that generally, while vegetable matters are distinguished by their great brittleness in the dry state, those of animal origin are characterized by a remarkable toughness, which reaches its highest degree in the fibrous formations of the skin. The pliability of thick skin dried in ether over chloride of calcium is very extraordinary. Other animal preparations at the same time preserve their original form in the dry state, the usual contraction of the parts being thus avoided. The whole intestines of a young dog treated in this manner formed a remarkable anatomical preparation, in which the delicate structures were preserved in the most complete manner upon drying. The lungs and liver, to preserve which vain attempts have hitherto been made, formed a light spongy mass, retaining completely their organization. It is more than probable that anatomists can make use of this process in many cases; as, for instance, in the microscopical examination of the kidneys, pancreas, &c., particularly in those which have hitherto required the solidification of the object by chromic acid, &c. The use of the ether in a liquid form is frequently not necessary. The skin of animals, animal membrane, &c., readily assume in an atmosphere saturated with the vapour of ether containing a suitable strongly hygroscopic substance, a condition similar to that of white dressed leather. A like satisfactory result, however, is not obtained in the desiccation of inorganic substances, oxide of iron, alumina, &c., in artificial media. It is obvious that this process may be rendered useful under suitable modifications for other purposes. It is a ready method, according to Reischauer, for removing acid bodies soluble in ether from their aqueous solutions, by putting them into an ethereal liquid with caustic lime or potassa.

In chemical research it is frequently desirable to have the means of producing a very low temperature; but owing to the trouble and delay in preparing a freezing mixture, it is seldom employed. Mr. Crookes has described a plan by which a very low temperature is produced, by forcibly blowing a mixture of air and volatile liquid through a fine jet.

The instrument is the well-known one made by Messrs. Krohne Sesemann, for the purpose of producing local anæsthesia in surgical operations, and the liquid recommended to be used is perfectly pure ether. Two ounces of liquid were put into the four-ounce bottle belonging to the instrument; the air was forced in by means of a small india-rubber hand-pump, and the jet was about the size of that of an ordinary mouth blowpipe. By means of small wires the inner orifice of the jet could be contracted at pleasure.

When the liquid used was ordinary ether from methylated spirit, and the distance of the bulb of the thermometer from the jet ½ inch the lowest temperature was – 20°·7 C., and the bulb of the thermometer became quickly coated with ice, condensed from the atmosphere. Water in a test-tube held in front of the jet commenced to freeze immediately. With pure ether, sp. gr. ·720 C., prepared expressly for anæsthetic purposes, a temperature of – 21°·6 C. was produced, and a considerable quantity of ice condensed round the bulb of the thermometer, so as to impede the cooling, unless occasionally removed. Absolute alcohol gave a temperature of + 8°·0 C. Pure methyl alcohol, sp. gr. ·803, + 1·1 C. Solution of ammonia, sp. gr. ·880, – 11·C. Chloroform, – 5·1 C. Bichloride of carbon, – 2·2 C. Bisulphide of carbon gave a temperature of – 17·6 C.; large quantities of ice condensed on the bulb, coating it nearly ¼ in. thick. In a few minutes the bisulphide of carbon ceased to issue regularly from the jet, and miniature snow-balls were blown out at intervals. The bisulphide of carbon apparently contained water. The temperature of the room was 18°· C.

Most of our readers are acquainted with the ingenious apparatus of M. Carré for the production of a low temperature by means of ammoniacal gas. M. Knab has proposed a new process for its condensation. Chloride of calcium absorbs its own weight of ammoniacal gas, which is again evolved on the application of heat. The chloride will serve an indefinite time. M. Knab considers that his discovery will be found very useful: 1, Because chloride of calcium saturated with ammonia is a dry powder easy of transport; 2, because chloride of calcium is of very little value; and 3, while water will only hold in solution 20 per cent. of ammonia, the chloride will hold 50 per cent., so that the cost of sending ammonia about will be greatly diminished.

Electricity.—M. E. Becquerel has presented to the French Academy a memoir "On the Thermo-electric Powers of Bodies, and on Thermo-electric Piles." In his last memoir the author stated that bars of sulphide of copper obtained by fusion were very differently endowed with electro-motive energy. He now publishes his discovery that all these bars may be made to exhibit an equal power by simply subjecting them, after fusion, to a dull-red heat for several hours. The second part of the memoir is devoted to an account of the electro-motive force of various alloys, in which he shows that an alloy of equal equivalents of cadmium and antimony may advantageously replace tellurium in the construction of piles for the study of calorific radiation.

M. Gerardin has described a *battery of iron turnings.* The zinc of a Bunsen's battery is replaced by iron borings. The iron is placed in common water. The porous vessel contains a solution of perchloride of iron in *aqua regia.* The positive pole is made of powdered coke agglomerated with paraffine. Such a battery may be made of large dimensions, and a great deal of electricity obtained at small cost.

M. Torreggiani has also described *a new battery* and a practical application of it. After repeated experiments, he has proved that a pile in which the positive pole is represented by metallic lead, and the negative by carbon, and containing a saline solution (an alkaline acetate), gives, besides electricity, a large quantity of pure carbonate of lead, which may be profitably employed. The author considers that this is an easy and innocuous way of making white lead.

All discoveries in electricity which have been made for many years have been surpassed in practical importance by one, the particulars of which were communicated to the Royal Society a few weeks ago by H. Wilde, Esq. Space will not permit of our giving more than a brief account of this invention; but in our next issue, we propose to lay before our readers a full account of his entirely new magneto-electric machine. The principle is not difficult to understand. An armature wound round with insulated wire is made to revolve rapidly in front of the poles of a large permanent magnet. The currents of electricity thus induced in the insulated wire are carried round a large electro-magnet, which is thereby excited to a very high degree. In front of this electro-magnet a second covered armature is rotated, and the electric current thus generated is carried round a third electro-magnet. It is from a rotating armature in front of this third magnet that the electric current ultimately used for heating or lighting effects is produced. At each passage round the electro-magnets, and induction in the rotating armatures, the electric current becomes magnified to an extraordinary degree, until ultimately it is powerful enough to melt iron bars in a minute or two, and to produce a light surpassing that of the sun itself.

The machine is driven by means of a steam-engine, and as almost the only current expense is for motive power, it is not an improbable supposition that ere long electric lights of the most intense description will be as common in large factories and public buildings as gaslights are at the present time.

X. ZOOLOGY AND ANIMAL PHYSIOLOGY.

(*Including the Proceedings of the Zoological Society.*)

Ethnology or Anthropology is one of those studies which are as yet in a very infantile condition, and those who pursue it have to content themselves with the accumulation of facts, waiting the time when their material may justify the establishment of those broad generalizations which constitute the foundations of a true science. Mr. Mackintosh has lately published some remarks on the "Comparative Anthropology of England and Wales,"* which in their disconnected character well exhibit the want of some systematic principles to connect the observations of the practical ethnologist. The paper is illustrated by a plate containing portraits of some twenty-eight individuals, male and female, from various parts of England and Wales; and it is from the study of physiognomy and habit that the author has attempted to draw some conclusions as to the sources of the population of our country. He remarks on the character and appearance of the inhabitants of various localities, and from his observations draws conclusions as to the races inhabiting different counties, much in accordance with those of previous observers. At the same time, it may be remarked that the evidence submitted—namely, a selected series of twenty-eight portraits—is hardly satisfactory with regard to the facial characters of such a various and mixed population as that of England and Wales. It is hardly a safe thing to theorize upon the similarity between the countenances of Professor Steenstrup and the inhabitants of the north and east of England; nor can Sir Bulwer Lytton's novels be accepted as works of authority in ethnology. A very detailed examination and very careful illustration will be necessary in order to establish many of the bare assertions and hypotheses contained in this pamphlet; it may, nevertheless, be valuable as indicating a direction in which research may be extended.

Mr. Luke Burke, the editor of the 'Ethnological Journal,' is at the present time publishing in his pages a series of articles on the "Principles of Ethnology," and it is much to be hoped that he may succeed in laying some solid foundations on which the Science may rest.

In the 'Bulletins of the Anthropological Society' of Paris last issued, is an interesting paper, by M. Paul Broca, "On the Seat of the Faculty of Articulate Language." He endeavours to show that the faculty of speech is specially subject to the third convolution of the frontal region of the cerebrum, and brings forward several cases of injury or natural deficiency in this part to support his view. It appears, however, that in the great majority of cases the left hemisphere of the brain was alone affected, whilst injury to the right hemisphere produced no effect. M. Broca explains this by reminding us that nearly every person is right-handed, and that consequently the left side of the brain has to take the lead in nearly all voluntary actions; moreover, Gratiolet has observed that the convolutions of the left hemisphere are developed at an earlier period than those of the right. Hence, M. Broca argues that it is the left-third frontal convolution which is pre-eminent in the faculty of speech, and that though when this is injured, by long trial the right side may be made to do its work, yet in the normal state the right side takes no very active part. He compares the case to the attempt to use the left hand for writing, when the right hand, which has been trained to work with facility, has been injured. M. Broca's argument is certainly ingenious, and will doubtless give phrenologists some hope of yet mapping out the convolutions of the brain to their respective "faculties."

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* 'Anthropological Review,' January, 1866.

The Sphygmograph, which is exciting some attention just now, is one of those ingenious instruments which have been devised of late years, promising really to assist medical men in reducing their art to something like a science. Its great merit is this, that it gives a permanent and minutely accurate record of a phenomenon which before was known only by the very unsatisfactory discrimination of the sense of touch.*

The sphygmograph is an instrument for producing a self-written record of the swellings and contractions of the arteries known as the pulse. Its inventor, Dr. E. J. Marey, is a Paris physician, who is well known for many valuable physiological essays. The main features presented by the instrument are the following:—A principal beam of light construction is fastened on the arm by carefully padded straps; to this is attached a lever of nearly the length of the fore-arm; the shorter arm of this lever rests gently but firmly on the pulse; at each rise of the artery and subsequent fall the motion is exactly imparted to the lever, and the end of the longer arm performs the same movements as does the shorter, but on a much larger scale. To the end of the longer arm is attached a fine-pointed pencil, in contact with which a smooth strip of paper is made to move by clockwork in a horizontal direction. The effect of this arrangement is, that a straight line would be drawn on the piece of paper were it not for the rhythmic perpendicular movement caused by the pulse, which results in the production of an undulated line, the waves in which represent the separate expansions of the artery; of course, it is evident that since the movement of the paper is invariably uniform, the variations in the pulse will be distinctly indicated by the height, length, and form of the waves; and accordingly we have a most accurate and valuable means of comparing the pulse in various individuals and under various circumstances. Some interesting results have been obtained by studying the pulses of diseased persons, and the instrument has been found to exhibit phenomena in the pulse which it was quite impossible to detect by the rough-and-ready means of the fingers. The "sphygmogram" of a person afflicted with a certain disease of the heart, for example, is found to exhibit a series of undulations, the ascending line of which is very long and tremulous, and but slightly oblique, while the descending is abrupt and nearly perpendicular. The application and value of the instrument will be apparent from these remarks.

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* 'On the Use of the Sphygmograph in the Investigation of Disease.' By Balthazar W. Foster, M.D., M.R.C.P. Lond., Professor of Clinical Medicine in Queen's College, Birmingham. 30 pp. Crown 8vo.

Dr. Edward Schunck has communicated a paper to the Royal Society "On the Colouring and Extractive Matters of Urine." He is led by his experiments to conclude that human urine contains at least two peculiar colouring matters,—one soluble in alcohol and ether, while the other is soluble in alcohol but not in ether. The existence of a third insoluble extractive matter appears very doubtful.

In our last "Chronicle" we noticed the researches of M. E. Alix, on the "Parturition of the Marsupials," in which he attributed the discovery of the mode of performance of this function to M. Jules Verreaux, and also on anatomical grounds supported Sir Everard Home's views in opposition to those of Cuvier and Owen. Prof. Owen has now sent a communication to the Academy of Sciences of Paris, in which he overthrows the claims of M. Alix to a discovery, and at the same time reviews his own labours on the question at issue, and gives an account of the parturition of a *Macropus major*, which he had isolated at the Zoological Society's Gardens for some time, several years since. It appears that M. Alix had only consulted Prof. Owen's researches through the medium of a Cyclopædia.

Dr. Drosier, of Caius College, Cambridge, has lately been making some observations on the Functions of the Air-cells and the Mechanism of Respiration in Birds. He remarks that several of the commonly received views are quite untenable, such as that the air-cells are intended to assist in supporting the bird in flight by rendering it lighter, in consequence of the rarefaction of the air in the air-cells and the hollow bones; and again, that the air-cells are a sort of second respiratory apparatus, so that birds may be described, as they were by Cuvier, as animals having a double respiration. In disproof of these views, Dr. Drosier has shown that a pigeon weighing ten ounces would have its weight in air diminished by less than one grain, in consequence of the rarefaction of the air in its air-sacs and hollow bones; so that the floating-power resulting from such rarefaction would be almost inappreciable. Again, the air-cells are so sparsely supplied with vessels, that they can offer but very little blood for oxidation. It has been frequently supposed that air passes from the air-sacs into the cavities of the peritoneum and pericardium, and even between the muscles. This is, however, an error, as was shown by Guillot and Sappey. Dr. Drosier conceives that the air-sacs are simply appendages to the lungs for the reception of air. The respiration of birds is necessarily very rapid and vigorous, and at the same time the lungs are small. The large quantity of air inhaled at a respiration is received into the air-sacs, and by the alternate contraction and expansion of the thoracic and abdominal cells, a continuous stream of air is made to play upon the naked capillaries of the lungs. The hollow bones Dr. Drosier believes are filled with air not for respiratory purposes, but to remove the moisture from the interior of the bones, which would otherwise accumulate and render them heavy. Dr. Drosier is intending to extend his researches and publish them in a volume.

Mr. Harry Seeley has lately published an article in the 'Annals and Magazine of Natural History,' entitled "An Epitome of the Evidence that Pterodactyles are not Reptiles, but a new Sub-class of Vertebrate Animals allied to Birds (*Saurornia*)." Mr. Seeley is a clever and persevering osteologist, and has been for many years working at the Pterodactyles, which are so numerous in the Cambridge Greensand deposits. He has in this paper succeeded in showing that the affinities between Pterodactyles and Reptiles are very little stronger than those between Pterodactyles and Birds; in fact, that though these flying lizards resemble birds and reptiles more than they do any other vertebrates, yet the resemblance is very small, and hence he separates them as a distinct group, *Saurornia.* It is, nevertheless, quite a question for consideration whether Pterodactyles depart more from the exceedingly plastic Reptilian type than do the Chelonians or Ophidians, or than do the Bat and Whale from the Mammalian type. It must be borne in mind that while Birds, of all Vertebrata, are the most fixed and uniform in their general structural form, Reptiles are among the least so; and hence it is no such astounding anomaly to discover a winged lizard, while the occurrence of a lizard-like bird might be deemed improbable.

M. Victor Fatio has been writing on the various modes of Coloration of Feathers. The question of changes of plumage has presented itself in various ways. Is a new coloration always the peculiarity of a new feather? or may the coloration sometimes undergo alteration in the same tissues? It is very certain that when a feather has once grown, its colour cannot be affected by nutrition, inasmuch as all communication between it and the blood-vessels is at an end—the pulp having dried up. M. Fatio therefore attributes the alteration in the colour of completely-grown feathers to the humidity of the air, temperature, light, movements, and the grease of the bird. The modifications produced by these agents are the various development of certain parts, the solution and diffusion of the internal pigment and the rupture of the external parts.

M. Gerbe has communicated some important papers lately to the French Academy on the larvæ of marine Crustacea. With regard to his observations on the vascular and nervous systems, there has been some little contention, since M. Milne-Edwards has inserted a note in the 'Comptes Rendus,' stating that he has much satisfaction in finding that M. Gerbe's results accord entirely with his own, published more than thirty years since. MM. Coste and Blanchard, however, defend the value of this part of M. Gerbe's work. It appears that no one had previously studied the *Phyllosoma*, and that the earlier observations had reference to a branchiferous disposition of the vascular system, while M. Gerbe has carefully described the vascular apparatus in these abranchiate Phyllosomatous larvæ of Decapods. In his last note published, M. Gerbe gives the following among the conclusions to be drawn from his researches. It is not until the fifth or sixth moult which follows birth that the general form of the adult can be detected in the larvæ of Podophthalmatous and Edriophthalmatous Crustacea, and it is to these transitory forms, so different from those of the perfect animals, that a crowd of false species, of false genera, of doubtful families belong, and even, in the case of *Phyllosoma*, an entire order which is spurious. With the exception of the lobsters, the larvæ of all genera are when born destitute of any branchial apparatus, and hence their respiration being tegumentary, the circulation is necessarily very different from what it afterwards becomes. None of the larvæ ever present even rudimentary reproductive organs.

The development and reproduction of the Nematode worms is a subject which has lately been receiving considerable attention. Professor Leuckart has been most successful in tracing the modifications of several forms. Herr Mecznikow, who has been working in Professor Leuckart's laboratory, discovered that *Ascaris nigrovenosa*, which inhabits the lung of the brown frog, produces larvæ which enjoy a free existence, *in which they attain to a sexual development*. This very remarkable discovery has been exciting some contention, inasmuch as both Professor Leuckart and his pupil are anxious to receive credit for it. The larvæ which exhibit this curious phenomenon differ considerably from their parents; their development was traced by keeping them in a watch-glass with moist earth, and a part of the contents of the rectum of the frog. By this manipulation many forms of Nematodes may be kept for study and observation, which would perish when kept in pure water only. Professor Leuckart has carefully watched the development of the embryos produced by ova from the female larvæ, duly impregnated by the males, and has traced them into the perfect *Ascaris nigrovenosa* in the frog's lung, and has found that they are all invariably females, so that there can be no doubt that the production of young in the parasitic *Ascaris* is entirely parthenogenetic. It is beyond doubt also, he says, that this mode of parthenogenesis is widely diffused among the Nematodes, and cites as a tolerably certain instance of it the case of *Filaria medinensis*. With respect to this species, it seems probable from Carter's observations that, as in *A. nigrovenosa*, there are two kinds of generations, a parasitic and a free, and if so, we should have an exact analogy with the parasite of the frog's lung.

Max Schultze's 'Archiv fur Mikroskopische Anatomie' is a journal which has been started by the Professor at Bonn, and has already attained to its fifth number. It contains many very valuable papers. Amongst others there have been three on various matters relating to those strange little creatures, the *Tardigrada*, or "bear-beasties," as the German name for them may be translated. Dr. Richard Greef contributed a paper on their nervous system to the first number, as also another in the last issue, relating to the genus Macrobiotus, both of which are excellently illustrated. A paper "On the Movements of the Diatomaceæ," by Prof. Schultze, in the fourth number, is one of great interest—it is the author's opinion that a sarcodic organic substance is spread over the whole external surface of the Diatom which is the chief agent in rapid movement. He does not, however, consider that this affects the question of the animal or plant-nature of Diatoms. The papers in this journal which are devoted to the mechanical wants of microscopists will be found very good. There are many useful and important pieces of apparatus described in its pages which English makers would do well to introduce for us into this country.

A paper, by Professor Leydig, of Tübingen, "On *Phreoryctes Menkeanus*, Hofm.," appears in the third part of this journal, and is well worthy of attention. This extraordinary worm was originally discovered by Herr Menke in a brook at Pyrmont, and it was first described by Hofmeister as *Haplotaxis Menkeana*, which name was afterwards changed to its present appellation. For a long time the only known habitat was the original site in which the worm was discovered, but it has since been met with by Leydig at Tübingen, and it is stated by Leuckart to be common at Giessen, so that we may hope to hear of its occurrence in this country. A second species, apparently belonging to the same genus, was described by Schlotthauber in 1859. The worm, which strongly resembles a Gordius, has a cylindrical body, about half a line thick and more than a foot long. When viewed alive, it is at once seen to present all the characters of a true Annelid. There are four rows of setæ on the sides and ventral aspect, each segment presenting on either side a larger seta, which is placed quite on the ventral aspect, as in the common earth worm, and a smaller one, which from its position might almost be termed dorsal. In the middle portion of the body the ventral setæ sometimes occur in pairs on either side, but more usually only one is met with. The setæ themselves have a slight sigmoid flexure, with a small enlargement in the middle. According to Schlotthauber, the proper habitat of the worm is moist earth; but according to Leydig's observations it would seem to be truly aquatic, or, at any rate, to require exceedingly wet mud for its abode.

ZOOLOGICAL SOCIETY OF LONDON.

Mr. St. George Mivart has, during the past quarter, communicated two memoirs to the Society, on the Anatomy of Quadrumana —a subject in which he has already been working for some time. One is on the dentition, and other points of structure, in the rare Lemurine animal *Microrhynchus laniger*, of Madagascar; the other is a joint paper with Dr. Murie (the prosector to the Society), "On the Anatomy of the *Lemuroidea*," principally relating to the myology of these animals.

The appointment of a prosector, and the building of a well-arranged dissecting-room in the Society's gardens, have, no doubt, done much to assist the study of comparative anatomy. Besides the above papers we have, as a result of this liberal movement, during the past quarter, an excellent paper by Dr. Murie and Mr. St. George Mivart, "On the Anatomy of the Agouti (*Dasyprocta cristata*)," principally in reference to the myology of this animal.

Among the papers relating to descriptive zoology are descriptions of three new monkeys, by Dr. Gray, *Cercopithecus erythrogaster*, living in the menagerie; *Nasua dorsalis*, from South America; and *Macacus inornatus*, also living in the gardens.

The Society has also lately obtained for its menagerie a rare monkey from Demerara, *Pithecia leucocephala*. Dr. Gray has also described a new Porcupine (*Acanthion Grotei*), specimens of which are in the Gardens and also in the British Museum; also a new Bat from Angola (*Scotophilus Welwilchii*), and a new Bush-bock (*Cephalophus breviceps*), as well as various mammals recently received from Port Albany, North Australia, amongst which were several species new to science.

A large number of new and rare birds have also been noticed and described at the meetings of the Society by Mr. Sclater, Mr. Gould, Dr. Hartlaub, and others. Mr. Tegetmeier exhibited a drawing of the Dodo (*Didus ineptus*), supposed to be an original one, from which it appeared that the plumage of this remarkable bird was white. Mr. Sclater and Mr. Salvin have laid before the Society a catalogue of the birds collected by Mr. Edward Bartlett during his recent expedition up the river Ucayali, in Eastern Peru, with notes and descriptions of the new species. The total number of specimens contained in Mr. Bartlett's collection was about 700, referable to 252 different species, of which twelve proved to be new to science.

Some valuable communications on Lepidoptera have been presented to the Society by Mr. A. G. Butler; and Mr. Flower at one meeting exhibited some insects captured in the Atlantic on board the ship 'Hotspur,' about 300 miles from land.

Amongst Mollusca, a list of species collected in Formosa, by Mr. Swinhoe, was furnished by Mr. H. Adams.

THE INTERNATIONAL HORTICULTURAL EXHIBITION AND BOTANICAL CONGRESS.

THIS grand meeting of English and foreign Botanists and Horticulturists, so long expected, took place on the 22nd of May, at South Kensington. This meeting is only one of a series, the first of which was held at Brussels in 1864, the next at Amsterdam in 1865, this year, 1866, in London; in 1867 the Congress meets in Paris, and in 1868 at St. Petersburg. It is expected that the country where the Exhibition and Congress is held, will endeavour to give as complete a representation as possible of its own Botany and Horticulture. Hence, in the late Horticultural and Botanical display at South Kensington, our great nurserymen and botanists were legitimately masters of the position. And well did they maintain our national pre-eminence in Horticulture! Never was there a larger or a better flower-show exhibited on English soil.

The general plan consisted of a rectangular plot of ground, 560 feet long by 300 feet broad, covered throughout by 40,000 yards of canvas, forming a vast pavilion or tent, overspreading about 3½ acres. The ground thus enclosed and covered was laid out as an ornamental garden, with broad and winding gravel walks, grass-terraced banks, waterfalls, artificial lakes, hills and valleys, and rockeries, the object of the whole arrangement being to display the plants to the best advantage, and give the visitors every facility for seeing them.

The view on entering the tent was truly beautiful and pleasing, reflecting much credit on the taste and judgment of the gentlemen of the Executive Committee, who devised the plan, and by whom all the arrangements were effected, *viz.* Mr. Gibson, Mr. Eyles, Dr. Masters, Mr. T. Moore, and Dr. Hogg. From the raised ground at the southern end, a very fine and comprehensive *coup-d'œil* was obtained of an undulating landscape of flowers, shrubbery, and trees, every zone and climate under heaven having apparently been ransacked of its botanical treasures to furnish the brilliant and imposing scene. A valley of Rhododendrons sloping down to the banks of an artificial lake!—masses of bloom grouped on every eminence and covering the green shelving banks, magnificent Azaleas and Pelargoniums in full dress, their stems and flowers tied to rings and hoops like a lady's crinoline—certainly a method of perverting the natural growth of the plant, which will be one day abandoned—Calceolarias and Cape Ericas in astonishing perfection, Roses of every hue, and Coniferous evergreens,—here and there a tall and noble tree-fern (*Cyathea medullaris*), towering aloft with its gracefully drooping fronds, Bananas, Palms, Dracænas, Pandani, Cycadaceæ, and other tropical evergreens—the whole scene was one from fairy-land.

It was, however, in the Orchid tent that the main horticultural attractions were centred. This department, separated from the rest of the pavilion by a canvas screen, 500 feet in length and 40 feet in width, was heated throughout by iron pipes, furnished gratuitously by Mr. Henry Ormson, the horticultural engineer. A broad, central, gravel walk, with sloping grass-covered terraced banks on either side, traversed its entire extent. On the eastern side the chief attractions were variegated-leaved plants, Caladiums, Marantas, Begonias, Lycopodiaceæ, Cypripediums, Japan Lilies, and ferns; on the western side, a space of about 400 feet of the bank was allotted to the Orchids, some of them of the very rarest kinds and of almost fabulous value. These gorgeous epiphytes of the tropical forest, which take the place of moss and lichen on the stems of the trees of the temperate zones, were here exhibited in all their beauty and fragrance, Vandas, Cattleyas, Dendrobiums, Onycidiums, Epidendrons, Odontoglossa, and Phalænopsis being the most conspicuous genera. We noticed also, on the same bank, the beautiful *Cypripedium barbatum*, and very fine samples of the *Sarracenia purpurea*, or North American pitcher-plant Beneath the bank of Orchids, on the same side of the tent, there was an interesting collection of economical and medicinal plants exhibited by Mr. Linden, of Brussels, including the tea, coffee, and cocoa shrubs, the spice plants, gamboge, mahogany, lignum vitæ, nux-vomica, gutta percha (*Isonandra guttata*), and India-rubber trees (*Ficus elastica*); and at the southern end of the tent were to be seen some most superb specimens of the pitcher-plant of the East Indies (*Nepenthes*).

Amongst the vegetable rarities on exhibition we noticed the *Ouvirandra fenestralis*, or lattice-plant of Madagascar; the *Raphanus caudatus*, or rat-tailed radish, first introduced into England from India by Mr. Bull. It is a straggling plant, about two feet in height, with Cruciferous flowers, and slender drooping pods which form the esculent portion or radish. Although the seeds of this plant when first introduced sold at the rate of eight for a guinea, yet as it thrives well in this country, it will probably soon become one of our commonest esculents. The *Lilium auratum*, the first bulb of which cost Messrs. Veitch 1,200 guineas, and Mr. Linden's exquisitely delicate white flower, the *Psychotria nivosa*, attracted universal admiration. There were also some very lovely specimens of Anæctochilus.

A box of 50 Alpine and herbaceous plants exhibited by Mr. James Backhouse, of York, not at all showy in appearance, nevertheless attracted considerable attention on account of the variety and rarity of its contents. We noticed in this box the North American *Cypripedium acaule* and *Dodecatheon integrifolum*, *Ranunculus glacialis* which flowers amidst the melting snows of the Alps, the *Myosotis montana* or mountain forget-me-not, which forms a dense little bush of large clear blue flowers, *Gentiana acaulis* showing as in its mountain home its large deep-blue flowers, the scarlet-flowered *Anemone fulgens*, and several other Alpine beauties, familiar to the tourist, forming altogether a most interesting collection, reminding, doubtless, some of the visitors of Chamouni, the Grindelwald, and the mountains of Switzerland, with their robes of eternal snow.

To attempt to enumerate all the rare and beautiful plants beneath the covering of that capacious tent is indeed a hopeless task. Messrs. Veitch alone had about 10,000*l*. worth of plants on exhibition, and 30,000*l*. would not have purchased the collection of Orchids. Some idea of the immensity of the collection may be gathered from the lament of a well-known Hammersmith horticulturist, that he could scarcely find his name in the garden although he had sent down twenty wagon-loads of plants and trees!

Prof. De Candolle, the President of the Botanical Congress, together with some of its most eminent foreign members, were presented to the Prince and Princess of Wales, who, accompanied by Prince Alfred, the Princess Helena, the Princess Mary of Cambridge, the Duke and Duchess of Cambridge, and Prince Teck, honoured the opening day with their presence.

Amongst the numerous foreign contributors to this truly international display, who must have been at considerable expense in the importation of their plants, the collections of Mr. Linden, of

Brussels, and Mr. Verschaffelt, of Ghent, stood pre-eminent. But to both English and foreign horticulturists, the public owes hearty thanks for a sight of so many rare and beautiful plants. When it is remembered that cultivators prize such plants quite as much as artists prize choice and beautiful pictures, the expense connected with their culture and transportation, and that they must necessarily suffer more than works of art, when shown to great crowds, by the conditions to which they are exposed, the noble emulation which could forget all personal and selfish considerations, and prompt to their exhibition on a rare occasion like the present, will be understood and acknowledged. The public indeed appeared thoroughly to appreciate this floral display, so that instead of four days the Council decided that it should be kept open for nine days.

On the evening of the opening day a banquet was held in Guildhall, the Lord Mayor presiding, to which 100 distinguished foreigners were invited as guests.

After the usual loyal toasts had been duly honoured, Sir Wentworth Dilke proposed the health of the foreign visitors, and especially Professor De Candolle, the President of the Botanical Congress. Professor De Candolle returned thanks in the French language. He said the unhappy state of things on the Continent had prevented many foreign botanists and horticulturists from coming. "What science wants above all is liberty, not only political liberty, which is to a certain extent very necessary; but, above all, that liberty which is accorded to the individual by public opinion. Those who seek for scientific truth require to be protected by the public, even more than by a free political system. Science prospers when allowed this freedom, and then neither revolutions nor war can stop its onward progress."

The Botanical Congress held its first session on the 23rd of May, in the Raphael Cartoon Rooms, in the South Kensington Museum. It consisted of about 130 representatives from foreign countries—France, Belgium, Holland, Germany, Russia, Italy, Switzerland, Portugal, and America being each represented in the Congress by one or more members; Professor Alphonse De Candolle, from Geneva, presiding. After the introductory address, which was delivered in the French language by the president, papers were read by the various botanists, British and foreign, in their own language, discussions occasionally following the reading of the paper. On the 24th, the Congress held at the same hour its second and final session. The attendance each time was large and brilliant, many ladies being present. These two meetings will long be remembered as a happy and instructive holiday by those who were so fortunate as to take part in them. Many were the personal acquaintances made there for the first time, by horticulturists and botanists, who had previously only known each other by name and reputation. Nearly fifty papers in English, French, German, and Italian were sent in to the Congress, the principal topics discussed in these papers being the practice of horticulture, vegetable morphology and physiology, structural botany, the geographical diffusion of plants, and their classification. The company assembled included M. De Candolle of Geneva, Professor Koch of Berlin, M. Reichenbach of Hamburg, M. Lecoq of Clermont Ferrand, M. Caspary of Konigsberg, M. Weddell of Poitiers, M. Meissner of Basle, Professor Morren of Liege, M. Schulz Bipontinus of Deidesheim, M. Van Houtte of Ghent, M. Linden of Brussels, Verschaffelt of Ghent, Van Heuzck of Antwerp, Wendland of Hanover, Triana of New Granada, and the principal British botanists: Bennett and Gray, of the British Museum; Berkeley, Bentley, Hogg, Masters, Howard, and Ward, of London; Dr. Daubeny, of Oxford; Dr. Moore, of Dublin; and Dr. Dickson, of Edinburgh.

In opening the Congress, the president, Professor De Candolle, said:—"Before I commence my address in French, allow me to say a few words in English: first, as a mark of respect to this great country, and next in explanation of my views for the conduct of the present and future meetings of this kind. We have to choose between two alternatives, either that every member should speak in his own language, or in that of the country where the Congress meets. This last method would destroy the equality between members which is desirable in every public assembly, not a few would be reduced to silence, or, at least, prevented from taking part in the discussions, and several distinguished men would, therefore, avoid international congresses. The other plan, of letting every one speak in his own language, appears to be much more convenient. For these reasons I shall address you in French, and in doing so I establish, in fact, the right of every Englishman to speak in English at Paris or at Berlin, at Florence or at Vienna, under similar circumstances."

Professor De Candolle then read his inaugural address. He commenced, by showing "the service that horticulture renders, or may render, to Botany. The most remarkable experiments of physiologists—*viz.* those of Hales, Duhamel, Knight, Gaertner, and M. Naudin—have been made in gardens. Horticulture has done much to advance the progress of physiological botany, but it has still much to do." M. De Candolle then suggested the construction of experimental green-houses and hot-houses, and gave his views as to the plan to be adopted in their erection, so as best to serve the purpose of the physiologist. "A building such as I propose, would allow of light being passed through coloured glasses or coloured solutions, and so prove the effect of the different visible or invisible rays which enter into the composition of sunlight. M. Von Martius placed some plants of *Amaranthus tricolor* for two months under glasses of various colours. Under the yellow glass the varied tint of the leaves was preserved. The red glass impeded the development of the leaves, and produced at the base of the limb, yellow instead of green; in the middle of the upper surface, yellow instead of reddish brown; and below, a red spot instead of purplish red. With the blue glasses, which allowed some green and yellow to pass, that which was red or yellow in the leaf had spread so that there remained only a green border or edge. Under the nearly pure violet glasses, the foliage became almost uniformly green. Now that plants with coloured foliage are becoming fashionable, it may interest horticulturists to know that by means of coloured glasses, provided they are not yellow, they may hope to obtain at least temporary effects as to the colouring of variegated foliage." "Nothing would be easier than to create in the experimental hot-house an atmosphere of carbonic acid gas, such as is supposed to have existed in the coal period. Then it might be seen to what extent our present vegetation would take an excess of carbon from the air, and if its general existence were inconvenienced by it. Then might be ascertained what tribes of plants could bear this condition, and what other families could not have existed, supposing the air had formerly had a very large proportion of carbonic acid gas." "Horticulture has a commercial tendency which may be carried too far. A horticulturist, who allows himself to be influenced by a scientific spirit, necessarily frees himself from over-selfish tendencies." The above extracts will show the spirit of this admirable address, and the enlarged and philosophical views with which it abounds. At the close of the reading a vote of thanks, proposed by Sir C. Wentworth Dilke M.P., and seconded by Sir Roderick Murchison, was carried by acclamation.

The following are some of the most important papers which were read at the two sessions of the Congress:—

Professor Caspary, of Konigsberg: "On the Change of the Direction of the Branches of Woody Plants." Professor Caspary has determined the following facts:—1. There is in winter a lateral movement of the branches of trees sometimes to the left, and also to the right-hand side, which movement is directly in proportion to the intensity of the frost. 2. The frost causes the branches of some trees to droop, and of others to rise, the extent of the downward and upward movement varying according to its mildness or severity. 3. In some instances the branches of trees exhibit both the above movements, rising when the frost is mild, and drooping when it becomes severe.

Mr. J. E. Howard, of London: "Observations on the Present State of our Knowledge of the Species of Cinchona." In this paper Mr. Howard mentions the fact of the great variability of the specific forms of this genus of plants. Every well-defined region of the Andes has its own prevalent and characteristic Cinchonas, which are incapable of being reduced to any one typical form. Mr. Howard believes that no species has been clearly proved to remain unchanged from end to end of the Cinchonaceous region. He has succeeded in obtaining, from a cultivated specimen of *Cinchona officinalis*, nearly as much quinine as from the bark of a plant of the same age grown abroad—probably the first time that quinine has ever been extracted from bark grown in Europe.

Mr. James Anderson, of Glasgow: "Observations on the Temperature of Water, and its Effects on Plant Cultivation." Mr. Anderson advocates the importance of employing water as warm as the air of the stove, or a little warmer, for watering tropical plants, especially orchids. Tropical plants so treated were invariably more vigorous and healthy. Those acquainted with Brazilian forests—the habitat of the Orchids—know that the rain-drops are always warm. This accounts for Mr. Anderson's success as a cultivator, and confirms the truth of his views.

Professor De Candolle, Geneva: "On a Recent very exact Measurement of the Diameter of the Trunk of one of the gigantic Sequoias of California." M. De Candolle exhibited a strip of paper reaching nearly across the room, and in explanation said that it was an exact measurement, recently made by M. De la Rue and an assistant, of the diameter of one of the gigantic trees of California—that known as the "Old Maid." The trunk of this tree had been broken off by a storm at a height of 128 feet, and its base now forms the floor of a dancing-room. M. De la Rue had measured it in the following manner:—A slip of paper was stretched across the diameter of the trunk, and the annual rings were marked off by a pencil on the paper. This paper he now exhibited. The number of rings was counted by M. De la Rue and his assistant, one counting from the circumference to the centre, and the other from the centre to the circumference; 1,223 rings were counted in the one case, and 1,245 in the other. The mean of the two observations, which was no doubt nearly correct, gave the age of the tree as 1,234 years. The diameter of the tree, at the height of about six English feet from the ground, was 26 feet 5 inches, and its entire height, before the upper part of the stem was broken off, was, approximately, 350 feet. The Sequoias grew very uniformly. The lines on the slip would show that at the age of 400 or 500 years the annual rings were still thick, while, in ordinary trees, the layers became thin at from 80—120 years. This demonstration excited the most lively interest in the Congress.

Very able and interesting papers were also read by Professor Karl Koch, of Berlin, "On Systematic Botany;" Dr. Moore, of Glasnevin, "On the Climate, Flora, and Crops of Ireland;" Professor Horren, of Liege, "On the Influence of Gaslight on Plants;" and Mr. W. G. Smith, of London, "On the Corona of Narcissus." The President then declared the Congress at an end; on which Mr. Bennett, of the British Museum, proposed, Dr. Daubeny, of Oxford, seconded, and Dr. Schultz Bipontinus, of Deidesheim, supported, a vote of thanks to the President, and the meeting separated.

The following are some of the papers forwarded to the committee; but as the time of the Congress was fully occupied with the reading of those already sent in, they were unavoidably excluded, but will probably be published at some future day.

Mr. W. Bull, Chelsea, "On the Relation of Horticulture and Botany to Mankind in general;" Mr. B. Clark, London, "On the Floral Envelopes of the Lauraceæ;" Dr. Masters, London, "Double Flowers;" Dr. Hildebrand, Bonn, "On the Necessity of Insect Agency in the Fertilization of *Corydalis cava;*" Mr. Tuffen West, London, "On the Structure of the Testa of the Seed of the Solanaceæ."

It is impossible to enumerate all the public and private entertainments given. Mr. Veitch gave a magnificent *déjeuner* at his exotic nurseries, Chelsea, to the foreign members and English botanists, before the formal business of the Congress commenced on Wednesday. The most distinguished of the foreign visitors were invited to their anniversary dinner, by the President and Council of the Linnæan Society. A large number were hospitably entertained at Kew, by Dr. Hooker. The *conversazione* at the South Kensington Museum was equally brilliant and successful with the exhibition, being crowded with visitors, foreign and English, distinguished by their rank or scientific position. Upwards of 500 gentlemen dined at St. Martin's Hall, under the presidency of Lord Henry Lennox. M. De Candolle and our foreign guests appear to have enjoyed themselves thoroughly, having been received with true English hospitality. When the most distinguished *savans* of different nations meet together to advance science, which has already conferred so many benefits on mankind, each expressing his thoughts in the Congress in his own language, may we not hope that national animosities and prejudices created for political purposes between nations will be counteracted, and that mankind will continue to advance in the knowledge and appreciation of those physical and moral truths so essential to their happiness, and which alone can form the basis of a permanent and enduring civilization?

Quarterly List of Publications received for Review.

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1. A Dictionary; Geographical, Statistical, and Historical of the various Countries, Places, and Principal Natural Objects in the World. By J. R. McCulloch. New Edition, carefully revised by Frederick Martin. In Four Vols. Vol. I. *Longmans & Co.*

2. Notes on Epidemics, for the Use of the Public. By Francis Edmund Anstie, M.D. *Jackson, Walford, & Hodder.*

3. A System of Medicine. Edited by J. Russell Reynolds, M.D., F.R.C.P. Lond., Physician to University College Hospital and to the National Hospital for the Paralyzed and Epileptic. Vol. I. containing General Diseases. 960 pp. Demy 8vo. *Macmillan & Co.*

4. Rocks Classified and Described. A Treatise on Lithology. By Bernhard von Cotta. An English Edition, by Philip Henry Lawrence. Revised by the Author. 430 pp. Post 8vo. *Longmans & Co.*

5. A Treatise on Astronomy, for the Use of Colleges and Schools. By Hugh Godfray, M.A., Mathematical Lecturer at Pembroke College, Cambridge. 320 pp. Demy 8vo. With *Engravings on Wood.* *Macmillan & Co.*

6. Mind in Nature; or, the Origin of Life and the Mode of Development of Animals. By Henry James Clark, A.B., B.S., Adjunct Professor of Zoology in Harvard University, Cambridge, Mass. With over 200 *Illustrations.* *New York: D. Appleton & Co.*

7. Handbook of Natural Philosophy. By Dionysius Lardner, D.C.L. Electricity, Magnetism, and Acoustics. Seventh Thousand. Revised and Edited by George Carey Foster, B.A., F.C.S., Professor of Experimental Physics in University College, London. 400 *Engravings.* 460 pp. Crown 8vo. *Walton & Maberly.*

8. The Harmonies of Nature; or, the Unity of Creation. By Dr. G. Hartwig. 420 pp. Demy 8vo. 200 *Illustrations.* *Longmans & Co.*

9. Cholera in its Home. With a Sketch of the Pathology and Treatment of the Disease. By John Macpherson, M.D., late Deputy-Inspector-General of Hospitals, H.M. Bengal Army, and formerly of the European General Hospital, Calcutta. 160 pp. Crown 8vo. *John Churchill & Sons.*

10. The English and their Origin. A Prologue to authentic English History. By Luke Owen Pike, M.A., of Lincoln's Inn, Barrister-at-Law. 290 pp. Demy 8vo. *Longmans & Co.*

11. The Physiological Anatomy and Physiology of Man. By Robert B. Todd, William Bowman, and Lionel S. Beale, Fellows of the Royal Society, former and present Professors of Physiology and of General and Morbid Anatomy in King's College, London. A New Edition, by the last-named Author. Part I. *Longmans & Co.*

12. On the Anatomy of Vertebrates. Vol. II.—Birds and Mammals. By Richard Owen, F.R.S. 406 *Wood Engravings.* 600 pp. Demy 8vo. *Longmans & Co.*

13. Reliquæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part II. *Baillière.*

14. The True and the False Sciences. A Letter on Homœopathy. 40 pp. Demy 8vo. *John Churchill & Sons.*

15. Rain and Rivers; or, Hutton and Playfair against Lyell and all Comers. By Colonel George Greenwood. Demy 8vo. *Longmans & Co.*

16. On the Use of the Sphygmograph in the Investigation of Disease. By Balthazar W. Foster, M.D., M.R.C.P. Lond., Professor of Clinical Medicine in Queen's College, Birmingham. 30 pp. Crown 8vo. *From the Author.*

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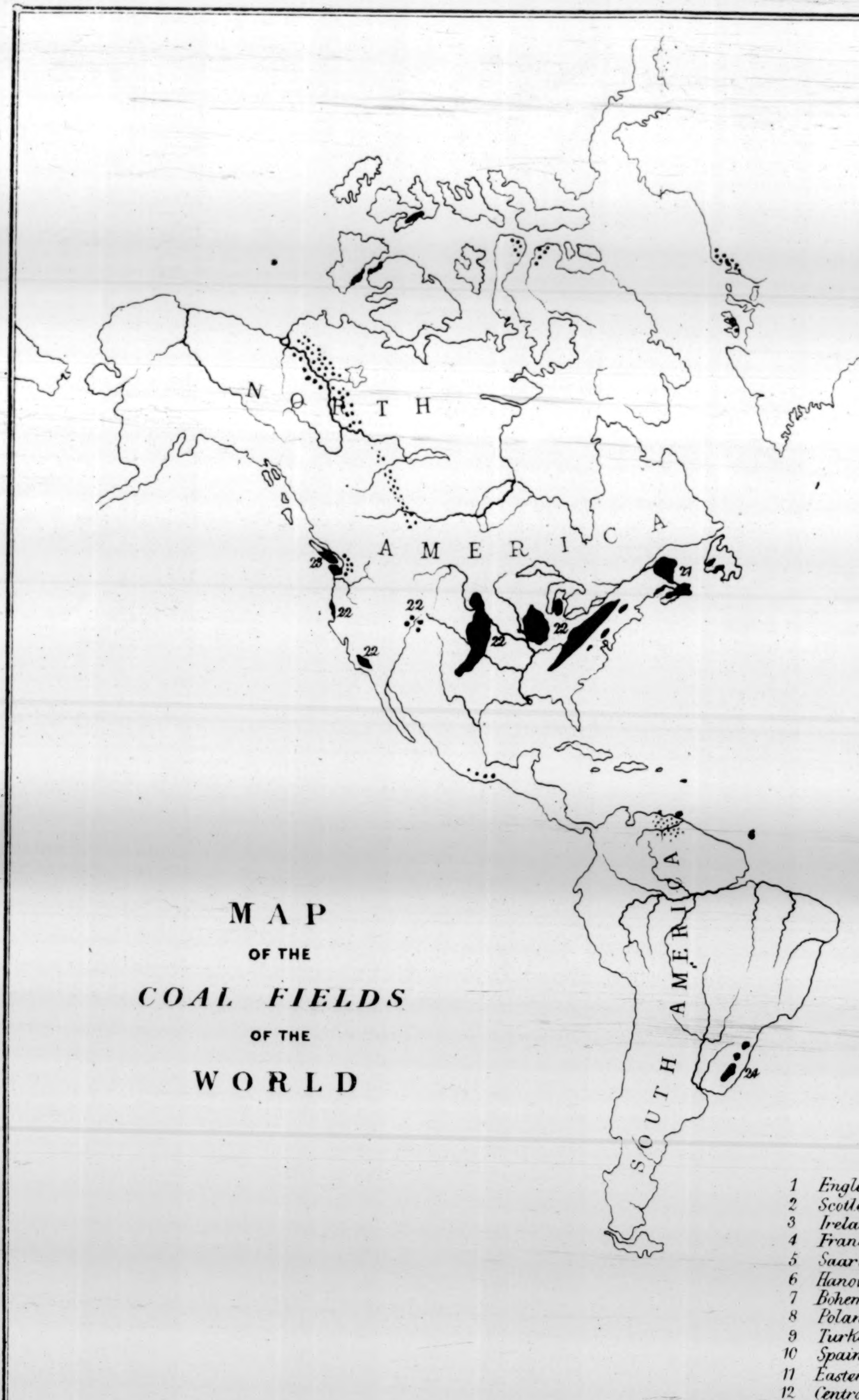

MAP
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COAL FIELDS
OF THE
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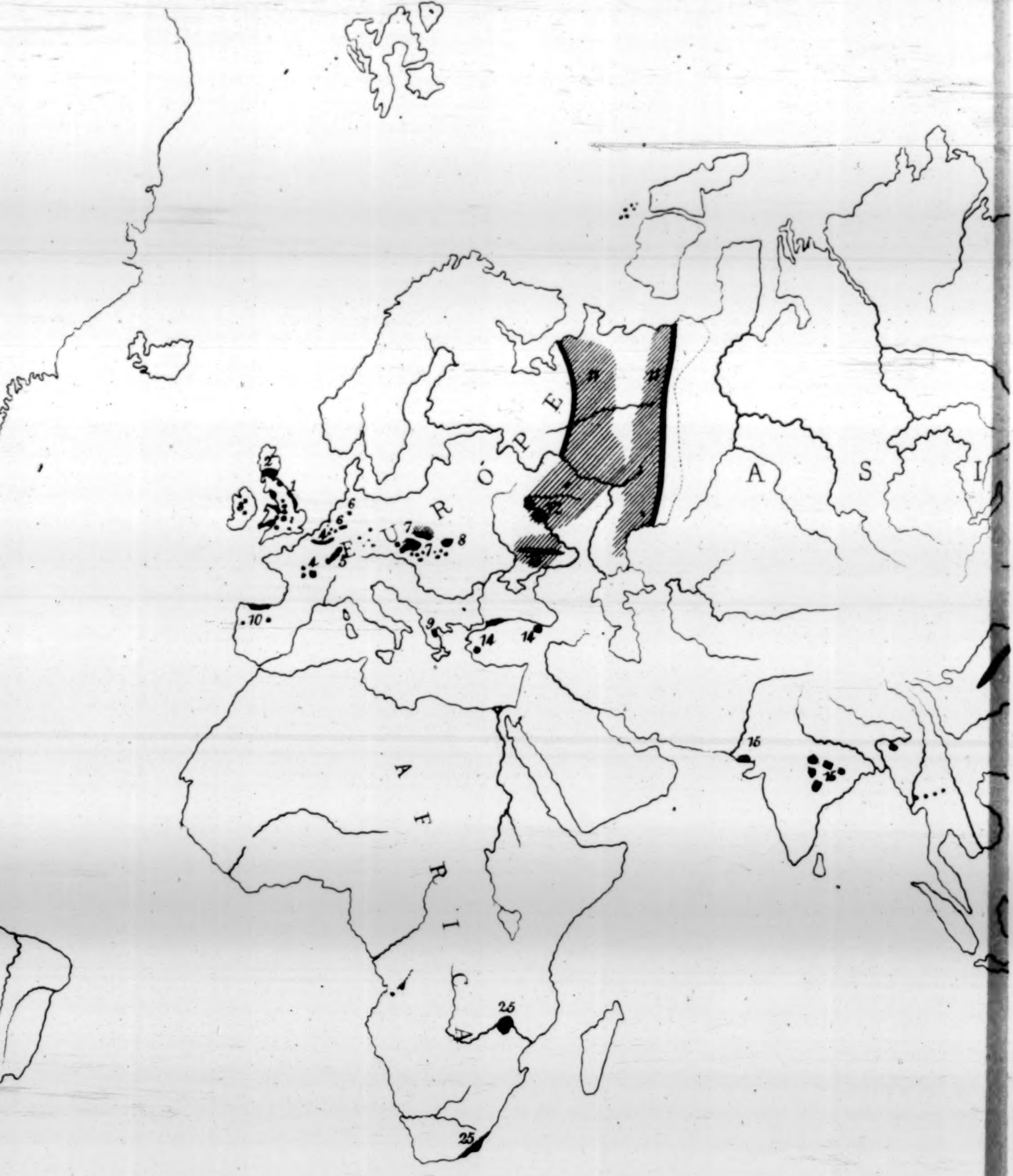

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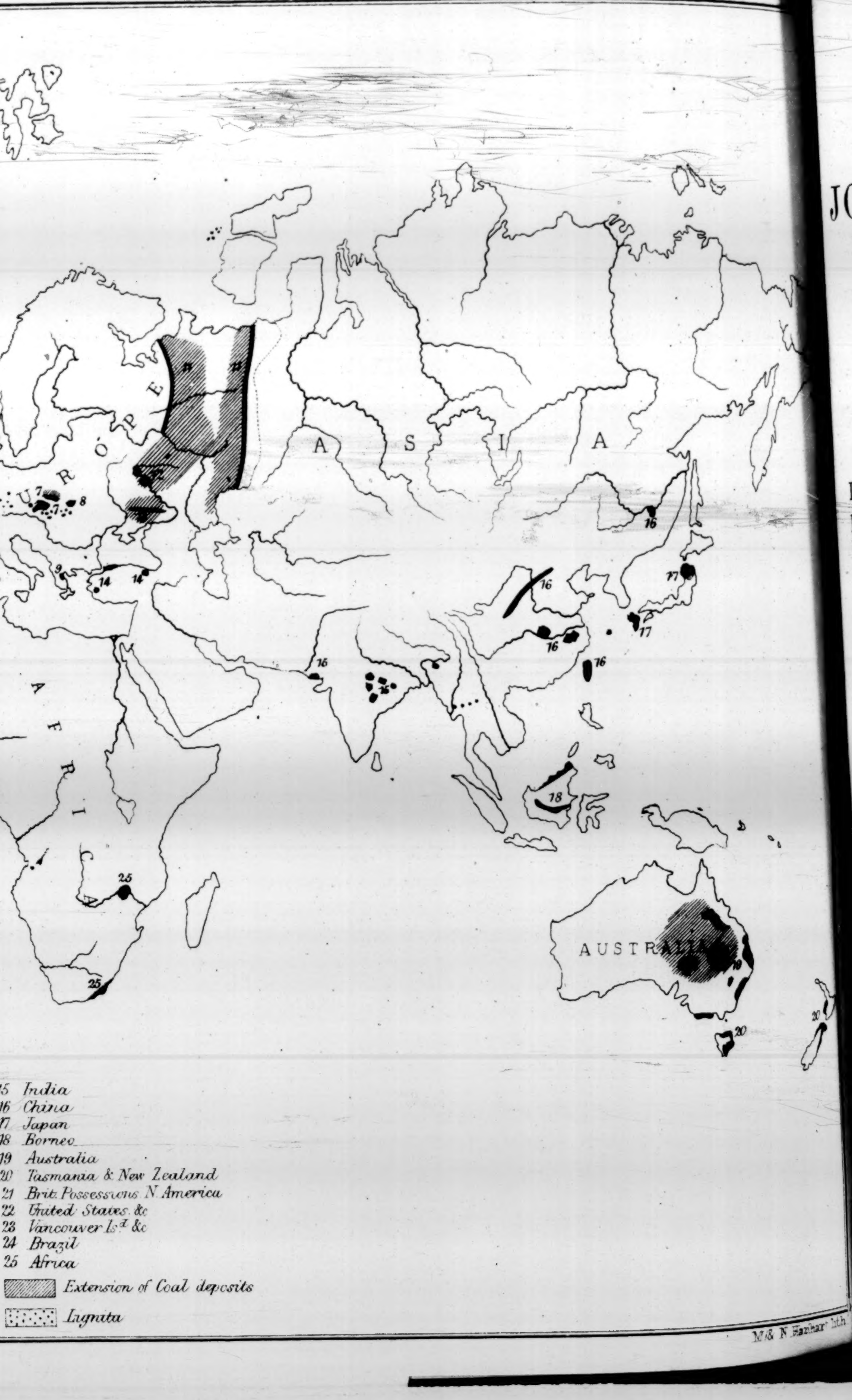

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